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SPECIAL TRAINING FOR PHYSICIANS IN ROENTGENOLOGY

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GENERAL practitioners and clinicians are equally cognizant of the increasing importance of roentgenology in the practice of medicine, for it is apparent that, like certain other special branches, all departments of medicine are being permeated by it. Almost daily, books on roentgenology as a whole and on certain particular phases of the subject are appearing in ever larger editions. Those who have read these and thus gained a theoretical knowledge of the specialty ask themselves the very pertinent question from whence their practical knowledge of the subject is to come. As undergraduate students they are accustomed to find instruction in every subject organized systematically from the foundations upward. It is, therefore, with considerable surprise that they find that for roentgenology the foundations have as yet been but imperfectly established.

The question as to how and in what institutions systematic instruction is to be organized and built up still awaits, in many countries, a definite solution. At present, the seeker after knowledge learns from the one more experienced what the latter is striving to accomplish and listens while he unfolds to him his views and observations collected from practical experience. The method of instruction smacks of the Middle Ages and is based more on the fact that both teacher and pupil are pressed for time than on the indications of the purpose in hand. To express it curtly: the school is lacking. On viewing the situation more closely, it will be seen that the two distinct types of instruction, that given undergraduate students, on the one hand, and the practical training given physicians, on the other hand, are pursuing methods that are diametrically opposed to one another. Undergraduate instruction, which lack of space prevents us from considering here in detail, has been partially worked out; at least, to the extent that suitable medical representatives of general roentgenology, making use of a method which is partly systematic and partly clinical in type, endeavor to impart to the student the fundamental principles of the specialty, while purely clinical lectures are relied on to enlighten him in certain special types of roentgenology.[1] The first and more fundamental part of the instruction of students is given, thus far, by the medical faculties of only the more enterprising, newer and smaller countries, whereas the more rigid types of medical schools have not yet introduced it.[2]

In contrast with the instruction for students, the special training for physicians is still entirely unorganized, with no regular plan as a basis, and therefore is also very inefficient. Although the quality of the instruction is defective, the opportunities of

[1] Holzknecht, "Die Röntgenologie und der Hochschulunterricht," Transactions of the Deutsche Röntgengesellschaft. Vol. XII; Eugen Weber, head professor (ordinarius) of medical roentgenology at the University of Kieff, "Zur Frage des Studentenunterrichtes in der medizinischen Röntgenologie," Fortschritte auf dem Gebiete der Röntgenstrahlen, Vol. XXIX.

[2] Communications of the Association des professeurs universitaires de la radiologie médicale.

securing instruction of some sort are abundant, as a result of the undeniable practical need. Nothing is farther from my purpose than to disparage skill and knowledge that have been laboriously gained. But it is impossible to overlook the fact that the methods by which those interested endeavor to acquire a practical knowledge of roentgenology are such that the best results cannot be secured, while the actual practical application of the knowledge thus gained is immeasurably defective. The causes for the negative results of the special training given physicians in roentgenology may be summed up as follows: (1) the inadequate length of the period of apprenticeship; (2) the giving of instruction in the practical application of the science before the fundamental principles of the subject have been mastered; (3) lack of coherency in the didactic methods employed, owing to the undue division of the subject into its branches, instruction in which is given in isolated clinics; (4) the group courses organized to counteract the defects due to lack of coherency (cf. Point 3 above): (5) no variation in method to meet the needs of individual physicians whose previous preparation differs widely, and (6) attempts to give special training to physicians who have had no practical medical experience and who are therefore inadequately prepared to receive instruction in roentgenology.

During the twenty years in which I have been engaged in the training of physicians, I have come to realize the far-reaching significance of the six points just enumerated. These defects it has been my constant endeavor, in recent years, to eliminate, and I will now state how I have gone about it and what modifications to that end I have introduced. It was relatively easy to reorganize the training in roentgenology of the minor specialties. To be sure, there is a danger, for the very reason that the difficulties presented here are not so great, that would-be specialists will fail to recognize such as exist and will not take the preliminary training seriously enough. If the applicants for a course in the roentgenology of a minor specialty already possess the practical and theoretical knowledge of the specialty in question, including its anatomy and pathology, the special training needed may be acquired either at the institutes for general roentgenology or, often better, at the clinics especially devoted to the specialty to be studied. However, at the latter the mistake is often made of neglecting the fundamentals of the subject, not only from the physics standpoint but also from the medicoroentgenologic. There is a tendency to simplify the roentgenology of a specialty and to reduce the general principles to the problems that most commonly arise in the course of practice. If an unusual case is later presented that requires a more profound knowledge, the roentgenologist is at a loss, for he lacks the training that would aid him in understanding the newer methods that are being constantly introduced. It is as if a bay window were projected from a house wall and not provided with proper support, for, lacking a thorough understanding of fundamental principles, the ill-prepared roentgenologist is compelled to rely on the weak support afforded by memorized object lessons. To prevent such sad experiences, I now have pupils who are being trained in the roentgenology of a specialty spend half of their training period in studying the principles of general roentgenology. The pupil then acquires useful knowledge and does not waver, while otherwise, in time of storm and stress, he would be like a ship without a rudder, or the prey of a treacherous memory.

The defects in the methods of training pupils in general roentgenology were incomparably greater. Irrespective of the views that one may entertain in regard to general roentgenology, its advocates exceed numerically the specialists in roentgenology to such an extent that their numbers promise to surpass the adherents of any other of the large specialties. It is useless to say that one does not approve of the course of developments. The instruction in general

roentgenology is here and must be properly organized. The results secured in the past have not been good. In some countries, not a single good result has been achieved.[3] Therefore, those who are in control of the situation express doubt as to whether general roentgenology is entitled to be regarded as a specialty or whether it should be taught, as to its special features, along with other main and special subjects. There are other countries in which a large number of well-endowed chairs in general roentgenology have been established.[4] The theoretical question as to whether roentgenology deserves to be recognized as a specialty is not yet decided; from the practical standpoint the question is settled in the affirmative. The fact that the clinics feel self-sufficient with their own laboratories (whether they will always feel so is another question); that they are satisfied with what they have been able to accomplish, and that they would prefer to have their specialty develop exclusively under their own tutelage, does not decide the matter one way or the other. It remains uncontrovertible that life's demands and the urge of hospital, private and *Krankenkassen* medical practice require general roentgenologists in enormously large numbers, and it goes without saying that these should be well trained for the work. The universities and medical schools cannot be expected to be always in the advance guard that launches new ideas and modes of treatment. That is not their purpose. They have, however, always responded to the needs of the hour and have no cause to accept any reproach because of their conservative attitude. But it is true that, by reason of their conservatism, entirely new modes of practical treatment, such as roentgenology, always have to be developed outside of the schools; but, when their scientific value has been established, they are welcomed into the fold and receive the mark of approval. This development has not been reached everywhere, with respect to roentgenology, and so, for the present, the training in general roentgenology must be given in the central laboratories of the large hospitals, with no, or only slight, connection with the universities, for thus the way for newer developments will be prepared and the practical needs will be met. The defects, the causes for which I have already stated, could be remedied in the following manner:

Since roentgenology is directly connected with all branches of medicine, the roentgenologist must be well trained in general medicine. He must be able to discuss dental granulomas, ethmoidal cell affections, quadrants of the bulbus, types of tuberculosis, also the more rare heart affections, abdominal symptoms, types of bandages for fractures, with the dentist as if he were a dentist and with the ophthalmologist as if he, too, were an ophthalmologist. His duties will relate to applied general roentgenology; or, to express it in approximate figures, there will be 10 per cent general roentgenology applied to 90 per cent medicine. To be sure, he will not be expected to compass the whole range of knowledge of these branches but only the knowledge of the borderline regions. But even for this the knowledge gained in the ordinary medical course will scarcely suffice. It will not be possible to gain this knowledge and experience, along with the study of roentgenology, except in the predominantly visual branches—not in internal medicine, for example. The physician who was not well grounded in internal medicine before he took up the study of general roentgenology will be at a loss when expected to discuss cases with the specialists who refer patients to him (this bears on Point 6).

If during and at the end of a special course of training for physicians in general roentgenology the instructor inquires carefully into the cases that turn out unfavorably, he will easily discover, as a rule, the causes of the failure. The mass of students who, on graduation from the gymnasium,

[3] Some countries have had to contend with conditions that blocked all progress. Discussion of these would lead us too far afield.

[4] Here roentgenology has received every encouragement from the first.

present themselves before the university instructors in medicine may, in spite of many differences, be regarded as homogeneous, as compared with the physicians who apply for training in roentgenology. No two of these have the same preparation and capacity. During their medical course, they became widely differentiated, from the standpoint of the relative amount of medical insight they acquired. Then, and afterward during their internship, their accomplishments and performances ranged all the way from zero to 100 per cent, in the various branches of medicine. The war period had, in some instances, a beneficent effect on their training, but in some cases the effect was just the opposite. Between the two extremes, "barely passed," with little or no practical training, and "carefully trained in general medicine and the specialties," there is a widely differentiated assortment of applicants, while the facts that their preliminary training was obtained in widely different universities in various countries, that language difficulties had to be encountered, and that wide differences in ability (mechanical skill, reasoning power, etc.) were found, complicated the situation very materially. The best practical results are exhibited by the group of assistant physicians of large hospitals who, during a four-year period of service, have received compulsory systematic training in all branches of medicine, especially if they had a natural predilection for internal medicine. Special knowledge in the fields of biology and pathology is also of value and always enhances the quality of the scientific performance, which, in our specialty, just passing through the storm and stress period of its development, has a practical value, on the one hand, in regions in which competition is keen, and, on the other hand, in order that the roentgenologist may readily take advantage of subsequent developments in his chosen field. When the previous preparation of the applicants falls below the ideal standard, good results cannot be secured unless (1) those who are entirely incompetent are eliminated, and (2) those who have had insufficient training endeavor to make up their deficiencies either before (internal medicine) or during their study of roentgenology (visual branches). Frequently, when the general education is below standard, though the professional training is far advanced, it is well to advise an applicant to abandon the idea of studying general roentgenology and to devote himself to some roentgenologic specialty. Some of the applicants have had a partial training in roentgenology in the clinics. For these the arrangement of a study plan is especially complicated.

After the initial examination of the pupils as to ability, previous education and available time to devote to their special training, it becomes at once apparent that every applicant needs a different course of study, and at first it might seem impossible to discover any way of meeting the needs of all without creating a tremendously large faculty. Yet, careful study of the situation shows how the roentgenologic institutes of large hospitals may readily solve the problem, provided they are properly conducted and keep their original purpose in view; namely, the best possible care of patients requiring roentgenologic treatment. As they must engage several physicians—at least one technician and several assistants—the division of labor is the natural principle by which individual performances are accomplished. The main basis for the subdivision of the work is the distinction between plate diagnosis and fluoroscopic diagnosis and therapy, which is due to differences in technic. It separates, at the same time, from a diagnostic standpoint, those with a surgical bent from those whose chief interest lies in internal medicine. Associated with the directors of these two departments, whose leanings are in a corresponding direction, are assistant physicians, who as full representatives (not aids) carry through the routine work and, in addition, devote special attention to certain fields. At long intervals, the directors of the two departments change places, while their rep-

resentatives change about more frequently, in order that, while pursuing the principal aim of securing the best possible performance of work, the universal aspects of the science may not be neglected. They all perform the work they have in hand while thinking aloud. They proceed slowly and gain experience in teaching as they go (*docendo discimur*). The pupils listen, offer aid, and eventually are allowed to participate independently, for direct practice is recognized as the fundamental principle applicable to their training. During intervals, as opportunity offers, they and affiliated roentgenologists and clinicians[5] hold general courses for the beginners and special courses and practice courses for the advanced pupils: introduction to general roentgenology, thorax diagnosis, diagnosis of the gastro-intestinal tract, practice course in internal diagnosis, diagnosis of internal diseases of childhood, practice course in making roentgenograms, roentgenology as applied to bones and joints, pathology of bones (for advanced students), roentgenology of the skull (*a*, for beginners, *b*, for advanced students), diagnosis of affections of the skeleton in children, chronic rheumatic affections of the bones and joints; diagnosis of teeth lesions, anatomy of the jaws and diagnosis of the auditory organs, roentgenotherapy, practice course in therapeutics, course in sketching, technic and roentgenologic physics, practice course in photography, physics in relation to technic, fundamental principles of roentgenology for nurses.[6]

The courses which, together with the study of textbooks, serve to systematize the knowledge gained from practical experience, and which are indispensable only for such pupils as are more ear-minded than eye-minded, are not combined for short periods, as this has been found to be impracticable, since it plays havoc with the routine examination and treatment of patients; the instruction becomes superficial, many points of great didactic value being overlooked, so that the general view of the discipline becomes distorted and the final results are correspondingly bad. As the longer period of training (short courses are refused, except for advanced students) allows ample time, the courses are automatically distributed according to the number of applicants or the period designed for training. Pupils often voluntarily take some of the more difficult courses a second time. Once a week, the professors and instructors meet with colleagues whose interests lie in the same direction (for example, teachers formerly connected with the laboratory but now engaged in the city) and hold conferences, together with discussions, on roentgenologic subjects that are brought up in the current literature. The more advanced pupils attend these conferences and often take part, in order, by means of thorough scientific discussion, to learn to realize the inadequacy and inevitable superficiality of all methods of teaching.

The books recommended for outside study and reading vary with each individual pupil. In addition, without following any hard and fast rules, the four essential forms of instruction employed in the special training in roentgenology given physicians consist of: textbook study, practical laboratory work, lecture courses and seminar. But, as already stated, no absolutely fixed schedule is followed. Taking account of the widely different capacity and attainments of the applicants, the use that is made of these four forms of instruction varies in the individual cases. It thus becomes possible to make the individual pupils, in spite of differences in previous training, fit into the scheme of things at the institute, without interfering with its major purpose, the examination and treatment of patients. The form of instruction, therefore, not only serves the institute well, but it must even be admitted that the physicians who are

[5] The corps of instructors: Professors Kienböck, Schüller, Holzknecht; instructors in roentgenology, Haudek, Sgalitzer, Eisler, Lenk; assistants, Pordes, Mayer, Borak, Wimberger; physicist, Spiegler; technician, Rosner; draftsman, Zimmermann; teaching nurses.

[6] Belonging to the course for the practical training of nurses.

thus being trained exert an enlivening mental influence on the teachers and workers, which serves to spur them on to greater effort and to make them more alert—in addition to the sense of satisfaction that comes from the feeling of having contributed to the growth of roentgenology as a science. It may be mentioned that not all the time at the disposal of applicants, provided it is at all adequate (the period varies greatly with the purposes, talent and previous training of pupils), is consumed in following the regular curriculum. A portion is reserved for tours and special studies in other institutes and clinics.

The pivotal point in this scheme of instruction is the initial examination of the pupil as to his capacities and previous training, followed by the endeavor to work out for him a plan of study exactly fitted to his needs. The hour that the experienced director of the institute spends thus on each pupil is, along with the organization of the courses, the most important feature of the work. I deem it advisable to introduce this or some similar organization of instruction in many other places, in order to prevent the overcrowding of certain institutes. It is quite feasible for several institutes of the same city to effect a common organization. The question as to whether the method of organization herein described is adapted to other branches lies outside of the pale of my judgment.

THE RELATION OF THE ROENTGENOLOGIST AND HIS WORK TO THE SURGEON [1]

By LOUIS FRANK, M.D., F.A.C.S., Louisville, Kentucky

THE intense interest and enthusiasm aroused in medical circles by Roentgen's discovery, in the nineties, of his X-rays, have been fully justified. The possibilities were early recognized, and the profession at once began a study of their application to the problems of diagnosis and, later, of therapeutics. To-day the value of the X-ray as a diagnostic aid has been firmly established; in fact, so valuable has this aid become that with a broad application of physics in conjunction with chemistry, diagnosis from history and by purely physical examination would seem to be almost a lost art.

The requirements, to say nothing of the time consumed to do the best radiological work, very early became such that quite properly roentgenology soon became a specialty. If, however, the roentgenologist desires that his work remain a specialty, he should see that those who are to come on the stage of activities should be fully and properly prepared to carry on this most important work, of which we believe the foundation only has been laid. This wonderful aid to diagnosis and treatment is now being taught as part of the curriculum in the medical schools, and just here lies one danger, shall we say, to roentgenology: A medical school can no more turn out true roentgenologists than it can turn out finished surgeons or obstetricians. The true roentgenologist should serve his apprenticeship, just as does the surgeon, and, likewise, he must have a complete and thorough knowledge of anatomy, physiology, pathology and embryology. How else is he to understand what he sees with his wonderful fluorescent light or retains for study and permanent record upon his roentgenographic film? More than this, he should be taught during his apprenticeship to collaborate closely with surgeon and internist. He should witness the operation upon those in the diagnosis of whose ailment he has assisted. He should study with the surgeon living pathology, checking himself in his work.

I can conceive of no department in medicine requiring a more general knowledge than does the work of you gentlemen. It is this knowledge which distinguishes you from the technician, from whom, with the cutters and fee-splitters, O Lord, deliver us!

The relationship between surgeon and roentgenologist should be an exceedingly close one, based upon mutual understanding of the inability of either to progress or to do the work to which humanity is entitled without the aid one of the other. What, for instance, would we do to-day about our fractures without the co-operation and aid of the roentgenologist? How could we treat them successfully? How could we differentiate them from sprains, from epiphyseal separations, or oftentimes from contusions? Imagine that department of surgery dealing with the urinary organs being compelled to abandon radiography! Radiography has made an almost exact science of the diagnostic side of urology, having enabled the urologist to recognize with exactitude not only the character of certain lesions but their location and extent, besides giving information not infrequently of unexpected pathology, otherwise insusceptible of recognition.

This being true, recognizing the preparation necessary to qualify one to engage in this work as a specialty, bearing in mind the vast gulf separating you from the technician, should we not collaborate more closely? Should not your invaluable assistance follow actual consultation with a full knowledge of the history and the opportunity to elaborate the same, rather than a request for an examination of some particular part of the body, as the alimentary

[1] Read before the Radiological Society of North America, at Cleveland, Ohio, December 7-11, 1925.

tract, or the sinuses, or the genito-urinary tract? If you are to do your best work, if we are to obtain the greatest benefit therefrom, it seems this would be the proper and logical procedure. Just as the surgeon does not accept the dictum from the attendant as to his procedure, just so should you ascertain the history, principal symptoms, and upon these, after consultation, do your radiological study. There is too great a tendency, I fear, to dictate by request the investigations you are to make, thereby restricting a free exercise of the knowledge and judgment you possess and curtailing the benefit to be given the patient by your work.

This brings up, as a corollary, the question of diagnostic responsibility, and as a consequence even the outcome of an operation which may result possibly in fatality. As a surgeon, I would not appear as desirous of shifting one iota of my own responsibility, yet I can readily see how one might come to occupy any but an enviable position as a result of radiologic error in the matter of interpretation.

In the field of fractures such might even become of medico-legal significance. In my own experience, a fracture of the neck of the humerus, with dislocation of the head, was incorrectly interpreted and failed of recognition for some weeks. So, also, have I opened the abdomen for radiographically diagnosticated gallstones to find the renal pelvis packed with small calculi. My roentgenologist had full histories, all data, and consultation was had in both the above instances, yet these errors occurred.

We recognize full well that in all activities of life it is impossible to eliminate human error, but the point is, Who is to bear the onus and take the responsibility of such failures? The layman accepts the roentgen-ray findings as positive, and it is, to say the least, quite embarrassing to make an explanation of such needless mistakes. More intensive study in both the cases cited would have revealed exactly what was wrong, and the question came to my mind, Who is responsible?

So I think that your relationship to the patient should be that of consultant, with a full history, the privilege of interrogation or investigative suggestion as you see fit, and a proportionate assumption of responsibility to the patient. These are some of the things which have suggested themselves to me in reviewing the relationship between surgeon and radiologist. Your work is too important, your field too great, the possibilities which lie in future developments too vast, to place your specialty on the plane of pure technical effort. As I see it, the science of radiology is the right hand of the surgeon, and upon you he will depend from the diagnostic side more and more. I can conceive the time when each structure of the body will be susceptible of visualization, when stereoscopic methods will be so improved that you will be able to fluoroscopically recognize each organ, because perfection will have been added to your armament.

Another phase of our relationship intrudes itself if we consider radiology from the therapeutic side, and in the field of treatment we must of necessity consider that other agent, the emanations of which are so closely allied, *viz.*, radium.

From a rather varied use of radium, and a more restricted observation of the results of the roentgen ray in the treatment of cancer, I have been forced to conclude that the greatest advance in the cancer proposition is along the lines of treatment with these two agents. Also, in the one we have a means of controlling pain to a marked degree, which in itself is a tremendous boon to the victim of this malady in the advanced stage. As it is, we must be exceedingly careful in denominating the disappearance of local disease as a cure. I believe that in radical surgery, supplemented by roentgen ray and radium, we approach more nearly the eradication of malignancy than by any other means thus far offered. No false hope must, however, be held out, and personally I never speak of cases as "cured," but prefer to say that the lesion has "disappeared."

Here, again, is a field for the closest co-operation, and particularly if the roentgenologist has not had a thorough surgical training; for it requires a training of such character to know in many types of disease just when all local evidence has disappeared. Notably is this true in carcinoma of that organ which is best suited for radium treatment, the cervix uteri. Most careful expert examination is necessary to discover deep evidence of recurring disease, and in our own experience with several hundred cases it has only too often been true that the patient and attending physician thought the disease relieved and later such deep involvement has been disclosed as to preclude further hope of success from treatment. Some of these patients had best have the radical operation after their treatment, and this must be determined by the surgeon. It is but natural that he who has but one or two things to offer in the way of treatment is quite apt to become prejudiced in favor of what he has to give. This must be carefully guarded against and can be done only by those of the two specialties working hand in hand.

I have often thought that roentgenology should be a surgical specialty and entered only through general surgery, just as any other department of surgery. It is quite evident, from a hasty study of the recent literature, that shortly general medicine, pediatrics, dermatology, urology and gynecology must be added to the accomplishments of the radiation therapeutist. Holzknecht enumerates some one hundred and twenty or more conditions in which it has been definitely established that roentgen-ray treatment is of value. Even brain tumors have been shown to be susceptible to improvement by treatment. Add to this, diseased tonsils, hypertrophied prostate, exophthalmic goiter, whooping cough, tuberculous peritonitis, pulmonary tuberculosis, the leukemias, and it at once becomes apparent that the field is simply enormous and the opportunities countless. The temptation is great, and unless the utmost care is exercised, the closest study made, and the sincerest co-operation with the other specialties in medicine maintained, one's enthusiasm may become so great that judgment will be warped. One swallow does not make a summer, nor one cure (?) mean that a specific is at hand. Careful investigation, an unbiased viewpoint, and lapse of sufficient time are all required before cures should be announced. Premature publications are only harmful, and results must be studied with a cold and critical eye.

I think we may say with conviction that in cancer of the cervix, radium offers probably as good, or certainly an equal, chance of complete local eradication as any other method of treatment, while in the borderline cases, combined at times with surgery, and in the inoperable cases, alone and rarely with surgery, it is undoubtedly the best form of treatment. From an economic standpoint it surpasses surgery in any form.

In cancer of the breast surgery with postoperative radiation is therapeutically and economically the preferable and certainly the best form of treatment to offer if the case is at all operable. If not, then radiation will relieve pain, retard the growth, and often for a time arrest the progress of the disease.

Fibromyoma of the uterus can in many instances be successfully treated by radium or by the roentgen ray. The surgical procedures have been so perfected, however, and the mortality so reduced that aside from the possibility of degenerative changes as a result of radiation, we believe hysterectomy — from the economic and every standpoint — is, in the vast majority of cases, indicated.

In exophthalmic goiter, after some considerable experience, we must conclude that the surgical procedures are the most satisfactory and would be our method of choice. The same holds true in tuberculous peritonitis, in which we are of the firm opinion, following some little observation, that the atrium of infection must be completely removed to obtain permanent results. We have seen no lasting improvement in any

case treated otherwise. In diseased tonsils, we have had no experience, nor have we made any observations.

In sarcoma, if susceptible of wide removal, radical operation followed by radiation would seem the method of choice, though lymphosarcoma and bone sarcoma had best be treated by radiation. In the former even though too extensive or of too long duration to permit of hope for relief, arrest follows treatment and life may be much prolonged. Operative removal of glands has not been satisfactory and in bone sarcoma we think radiation is the only plan of treatment which offers anything. The recent survey by Codman and Bloodgood has very clearly shown the futility of surgery.

With most of the hundred and twenty-one other diseases treated radiologically with improvement and benefit, we have had no experience and are not in a position to speak. It seems to us, however, that with further scientific investigation, close collaboration, keen observation and becoming modesty, the field of radiation usefulness, while not wide enough to embrace all ills, will be most extensively broadened.

PRELIMINARY REPORT OF THE COMMITTEE ON STANDARDIZATION OF X-RAY MEASUREMENTS

STANDARDIZATION COMMITTEE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

EDWIN C. ERNST, M.D., *Chairman;* OTTO GLASSER, Ph.D.; WILHELM STENSTROM, Ph.D.; N. E. DORSEY, Ph.D.; F. L. HUNT, Ph.D.; WILLIAM E. CHAMBERLAIN, M.D., and ARTHUR W. ERSKINE, M.D.

At the Mid-annual Meeting of the Radiological Society of North America (1925), a month prior to the International Congress of Radiology held in London, a resolution was introduced and adopted for the appointment of a Standardization Committee. The personnel of this Committee was to include no less than three physicists and three radiologists, for the purpose of studying the problems in relation to the adoption of a standard X-ray unit.

HISTORICAL

It might likewise be of interest to state that at the First International Congress of Radiology held in London (July 1 to 4, 1925), the initial scientific session of this historical meeting was devoted almost entirely to a discussion of international units and standards for X-ray work. The delegates of the various countries at this International Congress of Radiology included Sir William Bragg, Dr. Béclère, Dr. I. Solomon, Dr. Altschul (Prague), Professor Wintz, Dr. Glasser and other members of the present Standardization Committee of the Radiological Society of North America. They critically discussed not only the urgency of adopting a physical unit of dosage, a standard known quantity of X-ray with a given quality of radiation energy common to the radiotherapeutists of all countries, but they also reviewed the many advantages and disadvantages of the various individual units and methods of measurement in use at many of the radiological centers and clinics throughout the world.

At the conclusion of these valuable discussions, Dr. Béclère proposed a resolution, seconded by Dr. Finzi, that an International Committee be appointed to consider the establishment of a *uniform X-ray standard of intensity and an X-ray unit.*

At the meeting of the Physics Section of this Congress on July 3, 1925, this resolution was placed before the Assembly by the Chair, supported by Dr. Béclère and Professor Friedrich. After its final adoption, it was further resolved that at an early date the various scientific bodies throughout the world shall be communicated with in order that an international representative membership might be reached.

In the meantime it was agreed that the following members should act as a nucleus to nominate the International Committee: Sir William Bragg, Professor F. H. Hopwood, Dr. E. A. Owen, Mr. C. E. S. Phillips, Professor A. W. Porter and Professor Sidney Russ. This initial group of eminent physicists and radiologists reasonably assures the probable final solution of one of the most perplexing and difficult problems of the radiotherapeutists throughout the world.

In all probability this International Committee on Standardization will not be in a position to make its final recommendations prior to the next International Congress of Radiology, to be held in Stockholm in 1928.

Your Committee, therefore, realizes the need and urgency of continuing the present organized effort in this country of establishing an X-ray unit without further delay, since the problems involved are most complex and will require painstaking study over a long period of time. The scientific consideration of the theoretical physical aspect of a standard X-ray unit is simple indeed, compared to the adoption of a method of measurement that is practical and applicable to routine X-ray therapy.

MEASUREMENT PROBLEMS

First of all, the various quantitative determinations of the output of X-ray machines were given careful consideration; under the different voltage conditions, and with the various minimum and maximum filtration factors. Each individual method of measurement has distinct advantages and disadvantages, as observed and established by means of the well known photographic changes of the Kienbock strips; the color changes of barium platino-cyanid; the calomel and iodochloroform chemical reactions; the determination of absorbed energy by means of heat measurements; the physiological effects of radiations on the skin; the effects upon animal carcinomatous or sarcomatous tissues, germinating beans, fruit flies, plant tumors, fish eggs, ascari eggs and others. As emphasized above, all of these methods have their individual characteristic advantages, but as a whole they lack uniformity and accuracy, especially when comparing X-ray radiations of different wave lengths.

The selenium cell conductivity changes, calibrated in Furstenau Intensimeter "F" units, is an extremely simple method for checking the constancy of the transformer output. However, from the standpoint of a standard unit of measurement, the fatigue changes which do occur in the selenium cells may cause inaccurate readings.

IONIZATION METHODS

On the other hand, the ionization method, as described by Villard in 1908, in which he defines the quantitometric unit as "*that quantity of radiation which produces one electrostatic unit per cubic centimeter of air under normal conditions of pressure and temperature,*" has been most critically analyzed.

Because of its relative sound values, this same unit was taken up by Szilard in 1914, and further developed by Friedrich, Duane and Behnken. The latter three physicists improved the reliability of this unit by using larger air ionization chambers. By adopting this method they avoided the "wall" radiation, and thereby employed all of the electrons throughout their total ionizing path.

Dr. Behnken of the Physikalisch-technische Reichsanstalt, Berlin, has perhaps given us the most accurate and theoretical definition of the "e" unit, as described by him at the recent International Congress of Radiology. He changed the name of this "e" unit to the "Roentgen" unit (1 R).

The definition of this unit is as follows: "*The absolute unit of the roentgen-ray dose is obtained from that roentgen-ray energy, which, by fully utilizing the secondary electrons produced, and by avoiding secondary radiations from the wall of the ionization chamber, produces in one c.c. of atmospheric air of 18° C. (64.4 F.) and 760 mm. atmospheric pressure, such a degree of conductivity that the quantity of electricity measured by saturation current equals one electrostatic unit.*"

The German Bureau of Standards has taken further steps to bring into practical use the unit "R," on the basis of the definition given above.

Without going into detail as to the relative merits of the various methods of measurement, the Committee feels at this time that in all probability there are fundamental advantages in adopting the iontometric unit of X-ray measurement. The weak point of this method, as emphasized by Béclère, is that the present type of measuring apparatus will necessarily require further standardization.

In order to overcome some of these difficulties, Dr. Solomon in 1920 described an ionization unit which he called a "Roentgen" unit, and designated it by the letter "R," defining it as "*that amount of roentgen rays producing the same ionization as one gram of radium element at a distance of two centimeters from the graphite ionization chamber, in the same axis after filtration through 0.5 millimeter of platinum.*"

Fricke and Glasser, in 1924, defined the "R" unit as described by Szilard, Friedrich, Duane, and Behnken, by constructing

a small ionization chamber made of materials having the same effective atomic number as atmospheric air.

It is important to remember that commercial substances such as aluminum, horn, ivory, graphite, paper, etc., are some of the materials employed in the manufacture of the various measuring apparatuses. The individual values of these materials largely depend upon their purity and the differences of their effective atomic number from that of atmospheric air.

In 1923 Beets and Arens described an ionization chamber and an electroscope consisting of two circular parallel conducting plates. The filtered X-ray beam, in passing between these plates, traverses no substance other than air.

The comparison of the French with the German unit is as 2.25 is to 1. The (German) Behnken "R," therefore, is equal to 2.25 (French) Solomon "R" units, but this ratio changes with different wave lengths. All of the other present measurement units might be so converted, but unless an international unification is finally adopted, confusion will always be paramount to the simplification of our dosage problems.

SUMMARY

In attempting to solve these problems, the Committee is being guided by the individual observations of the members of this Committee, and the reported researches of other investigators in this country and abroad.

Primarily, a standard unit for the radiation dose must be defined; preferably an international one. The ionization in air as a means of determining radiation intensity has apparently proven the most satisfactory method thus far developed. It is therefore suggested that the electrostatic unit "e," as suggested by a number of investigators, Villard, Friedrich, and Duane, is the most practical standard unit of measurement. A most exact definition of this unit is given in the "R" unit of the German Roentgen Society.

It might be mentioned that the Committee realizes the fact that in connection with the quantity measurements of the X-ray output of any machine in standard units, it is equally essential to determine the quality of the radiation in terms of either the effective, the average wave length, the half value layer, or the coefficient of absorption. Charts for the deep intensity distribution of the human body should be very accurately determined. Standard methods and instruments must likewise be devised for the determination of the dose in the above mentioned unit. It must likewise be possible to measure and reproduce accurately such a standard unit, by employing an apparatus or simple device, practical in construction, to meet the demands of the average radiologist. In addition, the output of the machine must be constantly checked, either by a small ionization chamber in combination with an electroscope or by employing a large ionization chamber in combination with a robust galvanometer. Such an ionization chamber ought to be in a permanent position beneath the filter towards the patient, and the galvanometer or electroscope should be mounted so that it can be easily read by the operator.

Furthermore, it is essential that the different qualities employed must be taken into consideration, together with determinations of the biological effects produced in the above measured standard unit doses. Such measurements must be made upon the skin of the patient to include the back scattering. When employing fairly hard rays in the average deep therapy treatment, thirteen hundred "e" units have been observed to represent a dose which produces a skin reaction of the first degree. Radiation quality, however, has an important influence upon the number of "e" units necessary to produce the first skin reaction. For standardizing the output of the different apparatuses, it is advisable to determine the number of "e" units in air, *i.e.*, without back scattering, and to take the number of "e" units for the production of a skin dose

from tables worked out for the special conditions in use.

CONCLUSIONS

Therefore, the immediate problems under consideration by this Standardization Committee might be divided as follows:

(1) To study and establish a standard X-ray unit, physically defined.
(2) To determine the comparative variations of the X-ray dose measured in this unit for the different qualities of radiation energy.
(3) To devise ways and means of transferring such a unit of measurement from a standardization center or centers (preferably the United States Bureau of Standards) to different Roentgen institutions or private laboratories.
(4) To further study the proposed physical X-ray unit in relation to its equivalent biological effect or value.

The initial steps have been taken by your Committee to arrange for a conference with the officials of the Bureau of Standards at Washington, through the courtesy of its Director, Dr. Paul D. Foote, and the Director of the Department of X-ray Physics, Dr. Franklin L. Hunt, relative to the possibilities of future standardization researches. We have also been informed by Dr. Foote and Dr. Hunt that a new deep therapy X-ray equipment has been purchased for this special work. As soon as the necessary instruments are installed, the Bureau of Standards will welcome the cooperation of this Committee towards solving the problem of standardization by the establishment of a practical and uniform X-ray unit.

The fact that Dr. Hunt has accepted an appointment on this Committee further assures the success of our efforts towards a practical solution of this problem, provided, of course, our National Government in Washington will be able to co-operate with the Bureau of Standards in furnishing the necessary funds to permanently equip this department, so that neither the best interests nor the fullest development of the future scientific medical advances of the cancer problems may be thereby jeopardized.

DISCUSSION

Dr. Edwin C. Ernst (St. Louis): I might briefly add at this time that an X-ray unit which might be adopted should be carefully worked out so as to conform in every way with the probable recommendations of the International Standardization Committee unit of X-ray measurement to be adopted in 1928. We will endeavor to co-operate with the International Committee in every way possible. If the ionization unit is finally adopted and established in Washington at the Bureau of Standards, it will likewise be necessary to plan secondary standard instruments, portable in type, so that this unit can be transferred to other X-ray laboratories, either for scientific or therapeutic application. Such a standardization of an X-ray machine in standard units should preferably be done by physicists or representatives of the Bureau of Standards, who will take into consideration the quality as well as the quantity of X-ray radiation employed.

It is equally essential to be able to check the uniformity of the output of such installations by means of either an iontoquantimeter in a fixed position in relation to the tube, or by installing a robust galvanometer in circuit so that the operator may at all times either calculate or actually see the constancy of the output of the X-ray tube. Both types of checking instruments may be kept constant by a known quantity of radium. It must be remembered, however, that, in addition to the above electrostatic standardization unit or its equivalent, the sphere gap, voltage and milliampere readings should continue to be given the same consideration as in the past. It might be found desirable to have the Bureau of Standards recommend or actually employ

physicists for checking the output of the individual installations and perhaps issue a certificate to that effect to the radiologist in charge of the department. From a litigation point of view, that may be most valuable.

Dr. A. W. Erskine (Cedar Rapids, Iowa): This is, of course, a preliminary report, but it is worthy, I believe, of some discussion and possibly some action. To summarize the report, the Committee has made only two recommendations: the first is that, for the present at least, some ionization method is probably to be preferred; and second, for the present, or until an international unit shall be adopted, the Committee feels like recommending the use of the electrostatic "e" unit in this Society, or the "R" unit, which is the same thing.

Dr. Leo E. Pariseau (Montreal): I would like to correct a slight misconception in the statement of Dr. Ernst. It lies more in what he said in his comments than in his written paper. He said that the one gram of radium was rather a large quantity necessary to standardize a Solomon iontoquantimeter. It is true that the "R" unit of Solomon is defined in functions of one gram of radium, but Dr. Solomon does not use at all such a large quantity to standardize his iontoquantimeter. As a matter of fact, in Liege two years ago, I was present at the convention of the French association, and Dr. Solomon showed us how he standardized his iontoquantimeter. He uses only ten or twenty milligrams of radium. He casts a block of lead with a hole in the side, and he shoves this over the ionization chamber and the radium is suspended at a certain fixed distance from the chamber, so that when he speaks of one gram of radium, it is merely by calculation that he has standardized it, and, as a matter of fact, he has used only twenty milligrams, and that is what he advised. It is a practice that most of us can employ in an ionization chamber. It means nothing as a true physical unit, but it is a very, very good check-up for us to use on the ionization chamber by employing a block of lead with the radium needle inserted at a fixed distance. You should then always obtain the same rate of fall of the index needle if everything is right in your chamber.

Dr. H. J. Ullmann (Santa Barbara, California): Was that the distance from the outer edge of the chamber or the center of the chamber, that two centimeter standardization?

Dr. Pariseau: Apparently it was from axis to axis in both directions, so as to obtain the most homogeneous radiation.

(The question was repeated by Dr. Ullmann.)

Dr. Pariseau: From the wall of the chamber in this case.

Dr. A. Mutscheller (Long Island City, N. Y.): As a measure for the quantitative destruction of radiation, I believe the Committee has recommended the use of the effective wave lengths. It seems to me that the average wave length would be much more useful,—the effective and average are not the same thing. The effective wave length is obtained by determining the transmission of rays through two different metals, and that differs with the filter thickness. If you determine with one filter, you obtain one value; if you put in another filter, you obtain another value, and with a third filter you obtain still another value; therefore the statement that the average wave length is of such a value does not convey anything definite. The average wave length is the same as the half value determined by Meyer and Glasser, which gives one value for a given radiation, and is comparatively easy to determine, and if it is to be determined accurately, it can be accurately obtained from an absorption curve in copper. An absorption curve in copper has the advantage that the several determinations are necessary, and they in turn check up the accuracy of the method. If the values,

when properly plotted, do not lie along a straight line, then there is an indication that an error has been made or that there is a leakage or something which is incorrect. In that respect, therefore, I think that the average wave length would be a much better descriptive term and in fact it is used to a much larger extent than the effective wave length, and I believe it would, in general, be much more useful.

DR. R. A. ARENS (Chicago): I rise to a point of order, or rather to ask a question; is this a permanent Committee, or is the Committee to be disbanded at this meeting, or can we take further action now or at a further meeting?

DR. ERSKINE: Answering Dr. Arens' question: at the next Executive Session, the Chair will entertain a motion to continue or discharge the Committee and to approve its work.

MR. KEGERREIS (Chicago): I just want to say a word about two things of which Dr. Ernst spoke. I know both these men in the Bureau of Standards personally, and the type of work that the Bureau does is certainly such as to recommend it for a job like this. The other thing I would like to take out is the one word he put in when he said that perhaps the doctors should have an instrument. I want to put in the word "positively." What is the use of having a Bureau of Standards and all these things to check up, when things will change so tremendously? The only way to do this, if you are going to do it right, is to have an instrument there to tell you what you are getting all the time. There is no use in calibrating these things out in the third figure, meaning perhaps a thousandth, when you have, as is well known, variations during the treatment that will change things a great deal. You should be able to read this as you go along.

DR. W. E. CHAMBERLAIN (San Francisco): There is one way we can help the Bureau of Standards. When I visited Dr. Hunt a year and a half ago, he showed me very quickly that he was fully aware of the fact that the U. S. Bureau of Standards is not living up to its full opportunity until it establishes those standards of X-radiation similar to the standards of the metric system, the meter, the year, the gallon, etc. He showed me very plainly that the whole question there at Washington is one of governmental economy, and that the Bureau of Standards can go on with the electric light, photometric measurements for the General Electric Company and for the U. S. public because they have been doing that for some years, but that the economy program of our President and the administration does not allow the institution of new ventures,—things which have not been done in the past few years. As a result of his plea to me and to every one of us who has visited the Bureau of Standards, some of us have let our senators and representatives know that we feel that the Bureau of Standards should not be handicapped by the fact that this is new work, that we should not be penalized and have the Bureau of Standards kept out of this important field merely because the Bureau of Standards did not start it ten years ago when we were a little more extravagant in our budgets at Washington. As a matter of fact in a faculty meeting at Stanford, I had a chance to talk to Secretary Hoover, who has the immediate supervision of the budget from the Bureau of Standards, and he said he would welcome as many letters as radiologists cared to throw at him suggesting that the budget be amplified by the amount of money which Dr. Hunt and Dr. Foote feel would be necessary to enable the Bureau of Standards to take hold of the situation and put there in that beautiful vault at the Bureau of Standards some ionization chambers and instruments which should be there as experimental exhibits, or permanent instruments to which we can go for a standard, if necessary, a hundred years from now.

DR. ERNST (closing): I was glad to hear Dr. Chamberlain emphasize the individual problems of the Bureau of Stand-

ards. . . . This Committee has taken cognizance of these conditions and in order to help the officials in Washington, it might be necessary at a later date to send individual letters from representative radiologists and physicists to certain influential officials so that the necessary funds for this department may be obtained at an early date. I have been informed by Dr. Foote and Dr. Hunt that in the past they have been very much handicapped by the lack of funds, and that the future is even less promising. Therefore, under the present conditions, after completing their trip in Europe, the necessary appropriations for the Bureau of Standards available for continuing this work will be insufficient. In the meantime, however, this Committee expects to make every effort to help obtain the necessary funds for their department by urging the necessary appropriations through the regular channels in Washington.

Both Doctors are extremely interested in this whole matter and have arranged to attend this meeting for a conference with your Committee. Immediately after the first of the year it is the intention of the Standardization Committee to visit Washington for a combined conference at the Bureau of Standards. It is further planned to likewise co-operate with the committees of the other societies interested in this subject, together with the individual directors of all scientific institutions studying this therapy question, and thus, co-operatively, hope to get somewhere at the end of the next twelve months.

In reference to the subject of measuring the quality of X-rays, the Committee has been considering this matter from a practical standpoint. At this time I do not believe that we can discuss in detail the relative and the practical values of the average and the effective wave length methods of measuring the quality of X-ray radiations, but I might state that the half value method of measuring the quality of X-rays has appealed to some of the members of this Committee because of its simplicity. Perhaps it is not as scientific as it should be and therefore will be given further careful consideration. Individual groups of this Committee are planning to work on special problems in which they have been interested so as to expedite our progress.

In the meantime I wish to thank all of the members of this Standardization Committee and the many other radiologists and physicists for their helpful suggestions and sincere co-operation. We all realize the many complicated phases of this problem of standardizing the X-ray unit, and the relationship of such a unit of measurement to the many variable biological conditions. We will strive, however, to present for your consideration, a more definite or perhaps semi-final report of our efforts in behalf of humanity, at the next annual meeting of our Society.

THE IMPERFECTIONS OF THE STEREOSCOPIC MANŒUVRE IN RADIOGRAPHY OF THE CHEST

By JAMES J. WARING, M.D., and W. WALTER WASSON, M.D., DENVER

THE chest radiograph may be divided into three parts: the central mediastinal and cardiac shadow, the right lung field and the left lung field. Each lung field, again, may be divided (Fig. 1[1]) into several hundred small polygonal areas representing: (1) The shadows of two ribs crossing with or without the shadow of clavicle; (2) The shadows of parts of the clavicle; (3) The shadows of parts of individual ribs; (4) The free lung shadows, being the shadows of the soft parts of chest walls and pulmonary structures unobstructed by the shadows of bony parts.

Obviously the free lung areas afford the best opportunity for study of minimal tuberculous lesions. The shadows of the bony parts not only interfere with the demonstration of pulmonary detail by a screening effect but they necessarily create a lively doubt as to the nature, pulmonary or osseous, of coincident irregularities of ray penetration. Rotation of the shoulders effectually removes scapular interference, but the framework of the ribs is not so easily circumvented. The domes of the diaphragm and the central mediastinal and cardiac shadow very completely cut off certain portions of the lungs from study. The ribs are remarkably horizontal in early infancy and in senile and emphysematous chests, but in the normal adult, although more horizontal than vertical, they are decidedly sloping. On the other hand, the branches of the bronchial tree and their accompanying vessels, after leaving the hilus, take a predominantly vertical course. At all ages, but especially in childhood, superior demonstration of important small hilar opacities is obtained by a lateral shift. How much of this obstruction can be obviated by the stereoscopic manœuvre, and should the tube be shifted head-foot to decrease rib interference or should it be shifted laterally to decrease mediastinal and bronchial interference? Are the shape and slope of the ribs more or less similar at different ages and what effect will variations in these particulars have upon the efficacy of the stereoscopic manœuvre?

It has been noted that both the radiologist and clinician, consciously or unconsciously, in the study of minimal tuberculous lesions scrutinize most carefully, almost exclusively, the shadows in the so-called "free lung areas." How much of the whole radiograph is free lung area? How much of the right lung, how much of the left lung? Is there less free lung area in the outer zone of the lung field than in the inner zones? To answer these questions the chest radiograph has been analyzed in the following manner.

METHOD OF ANALYSIS

From careful tracings (Fig. 1) on ordinary tracing paper of chest radiographs of subjects of different ages, the small polygonal areas of various sizes and shapes representing free lung areas, single rib shadows, shadows of the clavicle and shadows of two ribs crossing were cut out with scissors and weighed in groups on a chemical balance. The completed calculations gave the weights of the tracings of:

(1) The whole radiograph.
(2) The central mediastinal and cardiac shadow.
(3) The whole right lung field.
(4) The whole left lung field.
(5) All the free lung areas of the right lung; of the left lung.
(6) All the single rib shadows of the right lung; of the left lung.
(7) All the areas representing the crossings of two ribs, with or without clavicle, on the right side; on the left side.

[1] Table I and Figure 1 are reproduced from a previous article, Waring, James J., "The Relationship of the Radiological Diagnosis of Tuberculosis of the Lungs to the Clinical Diagnosis," Radiology, March, 1925, IV, 188.

Then, since comparative sizes only were desired, it was considered that the area of any part of the radiograph was to the area of any other part or to the area of the whole as their respective weights. Weighing tests

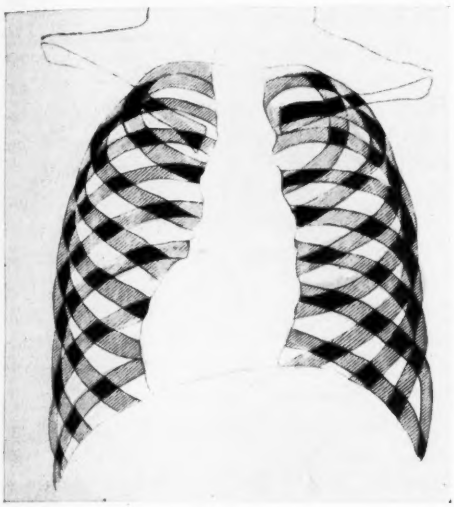


Fig. 1. Tracing of film of adult showing (1) free lung area, unshaded; (2) area obscured by shadow of one rib, lightly shaded; (3) area obscured by shadow of two ribs crossing, heavily shaded.

showed that different portions of the paper were remarkably uniform in weight. Table I shows for different ages, but in single instances only, in percentages of the lung fields: (1) The aggregate free lung area; (2) The aggregate area obscured by single rib shadows; (3) The aggregate area obscured by the shadows of two ribs crossing.

From the study of these figures it is evident that in the adult on the average less than one-third of the lung field is free from interference from the shadows of rib or clavicle. In other words, for the study of early tuberculous lesions, two-thirds of the lung field is practically useless. Under certain conditions the screening influence of the ribs may strengthen rather than diminish detail, but in such circumstances the shadows of minimal tuberculous lesions falling on free lung areas will be lost entirely. The ideal picture should bring out the uttermost detail on these free lung areas.

How effectively does the stereoscopic manœuvre obviate interference from the shadows of bony structures? In the first place the stereoscopic pictures may be studied separately and in the second place they may be studied stereoscopically. Fundamentally, the effectiveness of the stereoscopic manœuvre is dependent upon shifting the tube in a plane parallel to the plane of the obstructing ribs but at right angles to their long axes. The necessity for greater displacement increases (Fig. 2) with increasing slope of the rib shadows. That is, with a head-foot tube shift and ribs horizontal the shadow of an object opposite the middle of a rib to fall on free lung area on one of a pair of stereoscopic plates must be displaced one-half the width of the rib, but if the rib slopes at a 60° angle a shadow opposite the middle of this rib to fall on free lung area must be displaced considerably more than one-half the rib width. In the diagram (Fig. 2) with a vertical tube shift an object "O" opposite the middle of the 60° rib to fall on free lung area must be displaced the distance *og*, the hypotenuse of the triangle *ogm*. If this rib were horizontal, the object "O" would have to be displaced only the relatively short distance *om*, a leg of the right angle *omg*. The head-foot tube shift therefore is more valuable with a rib slope less than 45° and a lateral tube shift more valuable with a rib slope more than 45°. Since the slope of the shadows of the anterior arms is different (Table II) from the slope of the shadows of the posterior arms and since the slopes of both arms are constantly varying, ideal adjustment is impossible. For the following reasons, then, interference of the bony thorax is somewhat but not entirely obviated by the stereoscopic manœuvre:

(1) With the patient in the prone position on the plate whatever is seen within the chest box by *stereoscopic vision* is seen in its proper relation to the background formed by the shadows of the anterior arms of the ribs. In other words, the stereoscopic manœuvre is effective only upon in-

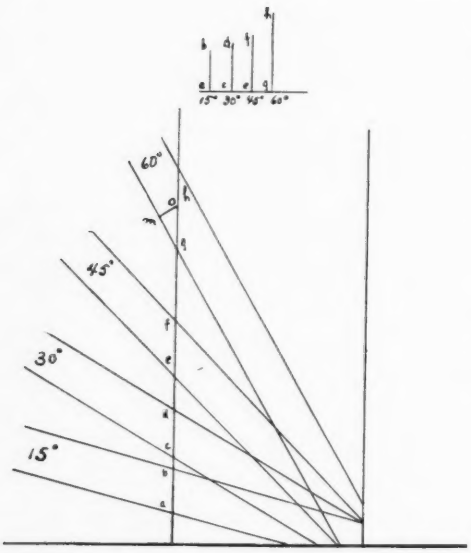


Fig. 2. To show that increased rib slope requires greater displacement.

tervening obstruction and is almost completely ineffective upon objects beyond the plane of the fixed point. The nearer the object to the screen formed by the anterior arms the more ineffectual the stereoscopic manœuvre. Accordingly, even if it were possible to remove all interference of the intervening screen formed by the posterior arms of the ribs, the screen formed by the anterior arms would still remain uninfluenced. The stereoscopic manœuvre may separate an intrapulmonary opacity from a coincident anterior rib shadow, and this detached shadow may then be studied on the successful one of a pair of stereoscopic plates, but, studied stereoscopically, the opacity will necessarily be seen in its true relation in front of, if it so lie, and therefore against the shadow of the anterior part of the rib.

(2) The more vertical the slope of the ribs the more effective is the lateral tube shift in removing rib interference, but the more horizontal the ribs the more effective is the head-foot shift. Since the ribs in the adult are more horizontal than vertical a lateral tube shift, although lessening interference both from the central and mediastinal shadow, and the predominantly vertical bronchial tree, would very slightly or

TABLE I

AGE	Heart Shadow % of Total	Right Side % of Total	1 Rib % of R. Side	2 Ribs % of R. Side	Free Lung % of R. Side	Left Side % of Total	1 Rib % of L. Side	2 Ribs % of L. Side	Free Lung % of L. Side
Twenty-four-hour baby...	44.75	27.59	51.22	7.31	43.90	24.75	44.44	5.55	50.00
Two-month child.....	45.67	30.59	52.00	4.00	44.44	23.47	55.26	5.26	34.21
Six-month child.....	42.92	35.60	45.20	2.74	52.05	20.00	65.87	4.87	29.26
Two-year-ten-month child.	36.90	31.19	55.00	16.72	28.24	29.52	52.42	16.12	31.54
Six-year-six-month child..	33.39	34.69	42.52	28.03	25.23	31.94	47.20	29.66	21.78
Nine-year child.....	32.42	36.25	52.78	16.72	30.49	31.22	50.76	20.99	28.62
Adult	27.57	35.54	46.91	22.45	32.52	30.16	49.90	19.09	29.55

Table showing relative size of lung shadows at different ages.

TABLE II

MEAN ANGLE OF RIB SLOPE TO THE HORIZONTAL

Left Side

Angle of slope of	posterior	arm of	1st	rib	18	degrees
"	"	"	"	2nd	rib	10	"
"	"	"	"	3rd	rib	13	"
"	"	"	"	4th	rib	17	"
"	"	"	"	5th	rib	25	"
"	"	"	"	6th	rib	27	"
"	"	"	"	7th	rib	32	"
"	"	"	"	8th	rib	43	"
"	"	"	"	9th	rib	47	"
Angle of slope of	anterior	arm of	1st	rib	53	degrees
"	"	"	"	2nd	rib	41	"
"	"	"	"	3rd	rib	50	"
"	"	"	"	4th	rib	45	"
"	"	"	"	5th	rib	45	"
"	"	"	"	6th	rib	53	"
"	"	"	"	7th	rib	60	"
"	"	"	"	8th	rib	53	"

Right Side

Angle of slope of	posterior	arm of	1st	rib	7	degrees
"	"	"	"	2nd	rib	17	"
"	"	"	"	3rd	rib	10	"
"	"	"	"	4th	rib	17	"
"	"	"	"	5th	rib	25	"
"	"	"	"	6th	rib	24	"
"	"	"	"	7th	rib	27	"
"	"	"	"	8th	rib	30	"
"	"	"	"	9th	rib	40	"
Angle of slope of	anterior	arm of	1st	rib	52	degrees
"	"	"	"	2nd	rib	50	"
"	"	"	"	3rd	rib	45	"
"	"	"	"	4th	rib	34	"
"	"	"	"	5th	rib	48	"
"	"	"	"	6th	rib	57	"
"	"	"	"	7th	rib	70	"

not at all decrease interference from the rib shadows. In the adult, *so far as the ribs are concerned*, whatever advantage lies in stereoscopic vision will therefore be obtained only from a head-foot tube shift. In early infancy and in emphysematous chests the ribs are remarkably horizontal and therefore *so far as rib interference is concerned*, a head-foot tube shift is the ideal method. Unfortunately at very early ages co-operation is never obtainable and stereoscopic pictures are at present difficult, if not impossible. The use of drugs, such as opiates and chloral hydrate or the administration of an anesthetic, to quiet the little patient, as recommended by some, is scarcely justified.

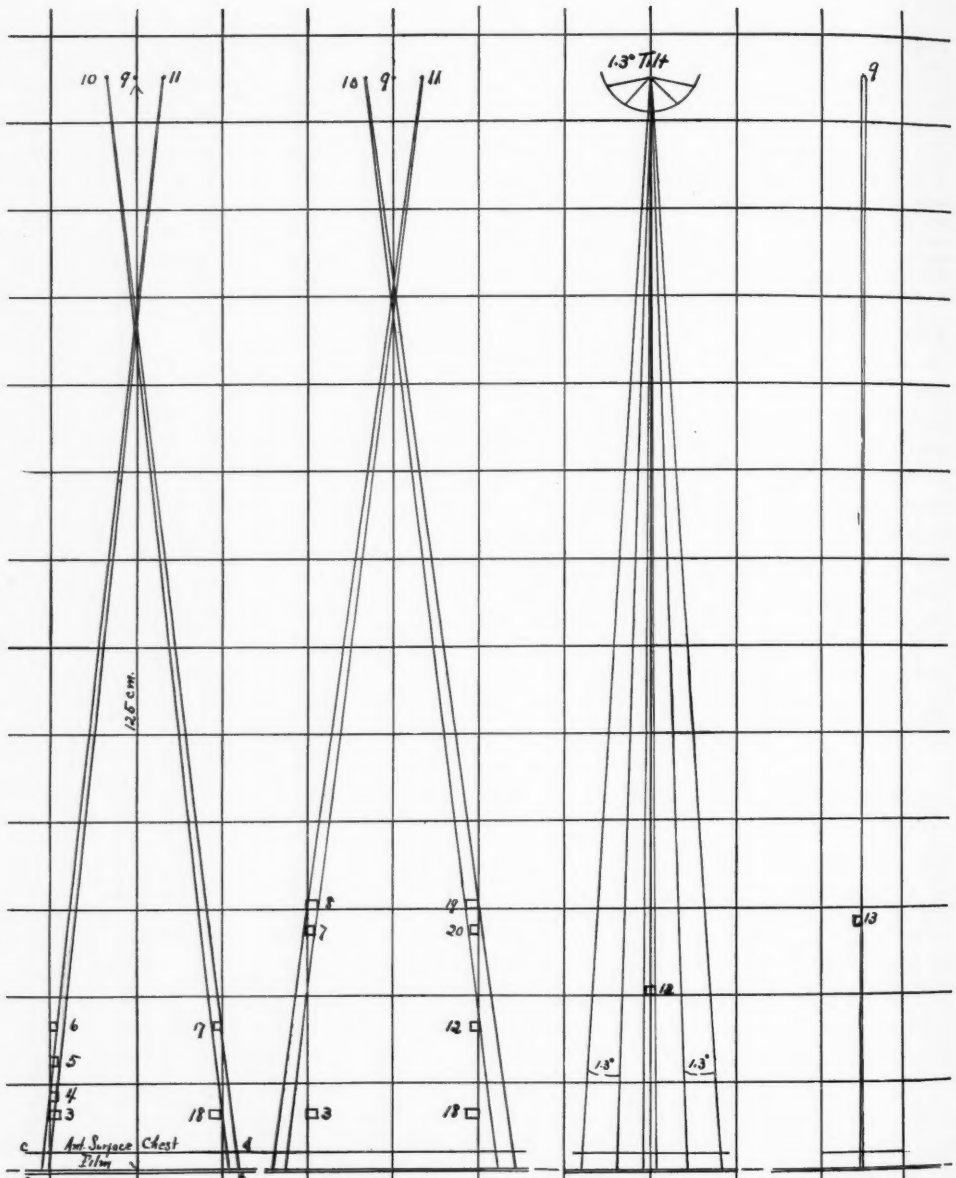
(3) Because of the varying slope of the ribs in the inner, middle and outer zones and the very different slope of the anterior arms from the posterior arms, a displacement adapted to dispel interference in the inner zone would be inadequate or excessive in the middle or outer zone.

(4) The polygonal areas of free lung space are smaller in the outer zone; that is, the outer zone is more closely overlaid by the rib shadows than either of the other zones.

(5) A standard tube shift is used in all cases, although (1) The widths of the ribs and the interspaces are not the same in all cases; (2) The thickness of the chest is variable; (3) The widths of interspaces vary in the same case with relative preponderance of costal and diaphragmatic inspiration; (4) The widths of interspaces may be different on the two sides in the same case.

(6) The shadows of the posterior parts of the first two ribs more or less overlap and together with the shadows of the third rib and clavicle overlie very closely the apex, one of the most important parts of the lung for study. More or less successful efforts have been made by several workers to secure better views of the apical regions (1, 2, 3).

So much is true for the stereoscopic study of a pair of plates. How much can be gained by the careful examination of the separate plates? Provided distance of the tube from the plate and amount of its shift are perfectly adjusted, an opacity coincident with the rib shadow on one film will be displaced on to free lung area in the other. Such perfect adjustment is impossible for all points in the chest for the reasons stated, namely, that the long axes of the ribs are not at right angles to the axis of the tube shift and, moreover, have a variable slope. It is shown in Fig. 3A that with a tube shift of 6.3 cm., and a focal distance of 125 cm., a rib width of 1.5 cm., an opacity 1 cm. in width must lie 14 cm. back from the anterior chest wall to be displaced from the coincident



In Figures 3A, 3B, 3C and 3D, *ab* throughout represents the film, *cd* the anterior chest wall; the objects 4, 5, 6, 7, 12, 17, 20 are 1 cm. square in size; the large squares are 10 cm. each way; the focal spot is 125 cm. from the film, the ribs 4 cm. from the surface of the chest; the tube shift displaces the focal spot 6.3 cm.; the focal spot itself is 6 mm. in diameter; 3, 18, 8, 19 designate ribs 1.5 cm. in width; chest thickness is about 20 cm. In Figure 3C the tube is tilted 1.3°.

Fig. 3A. Under the above conditions, this diagram shows that an object, 6, one cm. in diameter, must be situated at least 14 cm. back from the anterior chest wall, before its shadow will be clearly separated on one of a pair of stereoscopic films from the shadow of the anterior portions of the ribs. This is proven by the fact that with the object, 6, back 14 cm. from the anterior chest wall, a ray from the focal spot at 11 just touches 6 on the right side and just touches the rib 3 on the left side; on this film, therefore, the shadows of the object 6 and the rib 3 would be separated. After the tube shift, with the focal spot at 10, it is perfectly evident that the shadows of 6 and 3 would overlap; to

avoid confusion the lines from 10, to show this, are omitted. It follows that the shadows of all objects one centimeter or larger, within 14 cm. of the anterior chest wall, will more or less coincide with the anterior rib shadows on both members of a pair of stereoscopic plates.

Fig. 3B. This diagram shows that an object, 12, must be at least 14 cm. anterior to the posterior wall of the chest in order that its shadow may be clearly separated from the posterior rib shadow on one of a pair of stereoscopic films. The ray from the focal spot at 10 just touches the rib 19 on the left side and just touches the object 12 on the right side, separating their respective shadows on a film taken with the tube in this position. It is evident that with the tube in position 11, the shadows of 12 and 19 will coincide on the film; to avoid confusion, lines to show this are omitted.

Fig. 3C. This diagram shows that the advantage of tilting the tube is solely dependent upon the assumed greater value of the central beam of rays from the focal spot.

Fig. 3D. Rays from either side of the focal spot cross at a given spot within the chest and again diverge. This diagram shows that the shadow of this given spot is magnified and therefore blurred. It emphasizes the importance of a small focal spot and also the value of the proper relation or balance of the size of the focal spot to the working distance of the tube.

anterior rib shadow. Also (Fig. 3B) under the conditions, an opacity of similar size must be 14 cm. in front of the posterior wall of the chest to secure proper displacement. All points of similar size less than 14 cm. back from the anterior chest wall would probably fall on anterior rib shadow in both plates and all points less than 14 cm. from the posterior wall of the chest would probably fall on posterior rib shadow. In either case it is impossible to predict whether a point perfectly displaced from shadow of anterior rib will also be perfectly displaced from shadow of posterior rib.

Tilting of the tube in imitation of convergence of the visual axes of the eyes is of doubtful benefit as will be seen from a study of Fig. 3C. All beams in the hemisphere of rays sent out from the focal spot are of almost equal value. Tilting of the tube simply replaces one ray with another of practically equal value.

The blurring effect of rays from either side of the focal spot is illustrated in Fig. 3D.

CONCLUSIONS

(1) Analysis of the chest radiograph throws some light on the imperfections as well as the benefits of the stereoscopic manœuvre in radiography of the chest.

(2) The "free lung" areas are the most important areas on the chest radiograph for study.

(3) In the infant one-half, in the adult two-thirds, of the chest radiograph is obscured by the shadows of the bony parts.

(4) The head-foot tube shift best obviates rib and diaphragm interference; the lateral shift, mediastinal and bronchial tree interference.

(5) The more parallel the ribs, as in early infancy and in senile and emphysematous chests, the more effective the head-foot shift.

(6) It is impossible to predict the perfect displacement on to free lung area by the stereoscopic manœuvre of any point in the chest.

(7) Since stereoscopic study of a pair of plates necessarily shows any point within the thorax in its true relation against the screen of the anterior arms of the ribs, it is important to study separately each of the stereoscopic plates.

(8) Since it is impossible to obtain simultaneously, that is, on the one radiograph, ideal images of all parts of the chest, it is important to radiograph by special methods and positions the apex or any other part of the chest under particular scrutiny.

(9) Rotation of the tube is practically valueless.

(10) The diameter of the focal spot determines the best working distance of the tube.

(11) Even with a small focal spot at ideal working distance slight blurring is produced. This blurring must not be confused with the "fuzziness" interpreted as "activity."

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CHOLECYSTOGRAPHY BY THE ORAL METHOD [1]

By LESTER LEVYN, M.D., and A. H. AARON, M.D., BUFFALO, N. Y.

WE cannot refrain from a moment's retrospection to recall briefly the early workers in the field of gall-bladder roentgenology. Gallstones were first demonstrated on the X-ray negative by Carl Beck, of New York, in 1899. In 1904, Kohler and, in 1905, Mikuliez reported cases. In 1909, Matthias and Fett, of Konigsberg, reported two cases. In 1910, at the meeting of the American Roentgen Ray Society, nine cases were reported, three each by Pfahler and Cole of this country and by Haenisch, of Hamburg. In 1912, Thurstan Holland differentiated between gallstones and kidney stones. In 1913, Case, in a splendid article, stated that, with proper technic, cholelithiasis could be demonstrated in 40 to 50 per cent of cases in which stones were present. George and Gerber reported the accidental discovery of gallstones in conjunction with studies of the gastro-intestinal tract by means of the opaque meal. This occurred so often that they were the first to advocate examination of the gall-bladder area preliminary to every study of the alimentary canal. From then on, wonderful progress was made in the diagnosis of gall-bladder pathology by the development of refinements of technic which resulted in the frequent actual demonstration of stones, and by the elaboration of the so-called indirect signs.

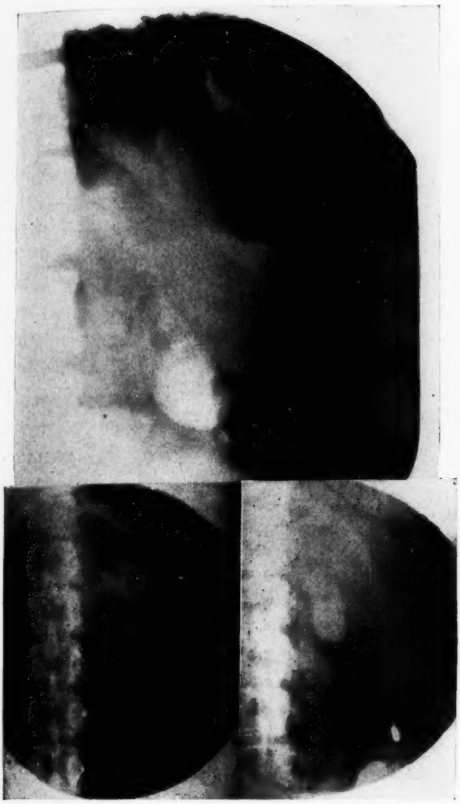
Many of us had dreams of some day being able to show the gall bladder as clearly as the stomach by filling it with opaque substance, but these dreams did not materialize until recently. The "open sesame" was revealed two years ago, for, in the *Journal of the American Medical Association* (February 23, 1924, page 613), there appeared an article with the following title: "Roentgenologic Examination of the Gall Bladder: A Preliminary Report of a New Method Utilizing the Intravenous Injection of Tetrabromphenolphthalein," by Evarts A. Graham, M.D., and Warren H. Cole, M.D., of St. Louis. The article opened with these words: "The revolutionary effect on the diagnosis of gastro-intestinal conditions which was made possible by the use of the opaque meal has given rise repeatedly to the idea that if, by some means, an opaque substance could be safely introduced into the gall bladder so that its contour could be seen with the roentgen ray, the diagnosis of many obscure and doubtful cases of cholecystitis might be made easy and accurate."

That modest preliminary report, which has been productive of extensive study and experimentation, has already succeeded in partially banishing the clouds from before our eyes and enabled us to see with a clearer vision than heretofore into some of the mysteries concerning which formerly we could but theorize, and ultimately will produce a revolutionary effect on the accurate diagnosis of gall-bladder conditions.

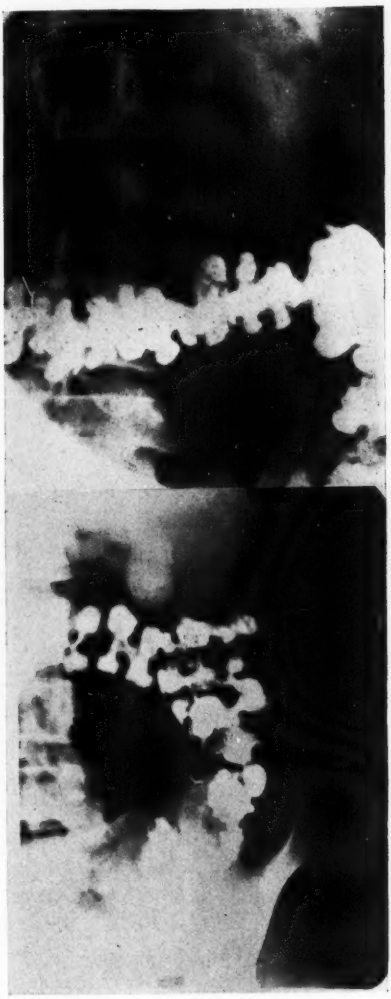
Graham and the associates who collaborated with him in this remarkable discovery have made the most important contribution to the science of roentgenology since Cannon announced his study of the intestinal movements in dogs and cats by means of giving large doses of bismuth, and its application subsequently in examination of the gastro-intestinal tract in humans by Rieder, of Munich.

The diagnosis of intra-abdominal lesions undoubtedly constitutes one of the most difficult fields in the realm of medicine. Almost daily in our work we see revealed on the operating table pathology which was not indicated by clinical and laboratory findings, so that the advent of any new method that proves of value in pre-determining existing pathology is a great accomplishment, and the writers wish to take this

[1] Read before the Radiological Society of North America, Cleveland, Ohio, December, 1925.



Figs. 1 and 2. Normal gall bladders.



Figs. 3 and 4. Normal cholecystograms.

opportunity of paying tribute to Graham, Cole and Copher.

Following publication of the Graham technic, the intravenous method was used exclusively by the early workers, but varying degrees of reaction, from mild to extremely severe, with which all are familiar, occurred. This factor made it essentially a hospital procedure and militated against its universal adoption. It is interesting to note that the subject of intravenous medication was discussed under "Current Comments," *Journal of the American Medical Association,* November 21, 1925, page 1645: "When the introduction is by way of the alimentary tract the peculiarities of the portal circulation are such as to compel most of the absorbed products to pass through the liver prior to discharge into the systemic blood stream. Direct intravenous injection involves difficulties of technic, with the possibility of local injuries to the peripheral blood vessels at the seat of operation. It presents dangers of bacterial contamination; the vehicle as well as the drug is immediately foreign to the blood, and other objections have presented themselves. The Council on Pharmacy and Chemistry has taken a decidedly conservative attitude toward the recognition of the scores of products intended for direct intravenous use. Intravenous injection of a large vari-

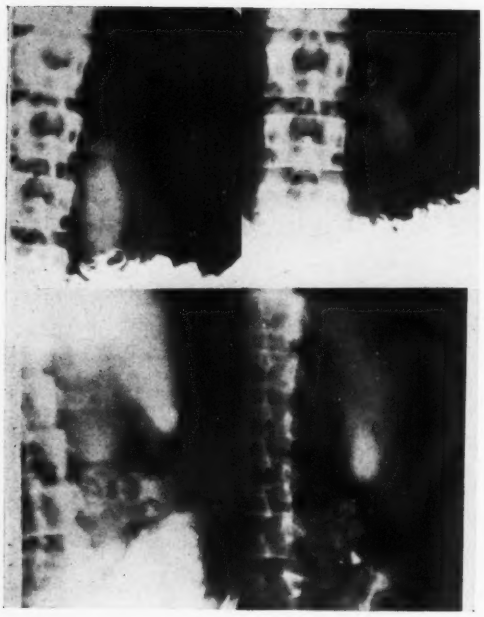


Fig. 5. (*a*) Normal-appearing gall bladder. (*b*) Diminution in size one hour after ingestion of food. Note proximity to spine.

Fig. 6. Gall bladder showing change in size before the taking of food and one hour after.

ety of substances caused definite and important changes in arterial blood, accompanied as a rule by disturbances in physiologic function. In experimental animals, upsets in these processes were indicated from changes in blood pressure, and in pulse and respiratory rates, ranging from moderate to profound and frequently resulting in collapse and sometimes in death. Hanzlik, of the Stanford University School of Medicine, has suggested that the basis of the blood and symptomatic changes resulting from contact with a variety of agents physically and chemically unrelated, rests fundamentally on disturbances in important physical and chemical mechanisms of the blood and tissues. It should be noted that many of the untoward effects described are not attributable to the mere toxic properties of the substances tested, for they do not usually behave in the same way when otherwise administered. Our ignorance in this field still demands the greatest caution and conservatism. As Hanzlik expresses it, "the burden of proof rests on those who assert that intravenous injections are not injurious or dangerous."

Stewart, Einhorn and Ryan obtained satisfactory visualization by jejunal administration through the duodenal tube, but numerous severe reactions resulted. The self-evident unpleasantness of this procedure scarcely recommended it for routine use. Recognizing the advantages of simpler methods, many workers proceeded to experiment with oral administration of the dye. Chief among them were Whitaker, Milliken and Vogt, whose first work was with dogs which were given 0.4 gram of tetraiodo per kilogram of body weight, through a stomach tube in 1 per cent solution. Very good shadows were obtained in from twelve to fourteen hours. With the exception of vomiting in some of the animals, there were no untoward effects and the test was accordingly carried out in a human subject. A dose amounting to 0.1 gram per kilogram was given in a 5 per cent solution, followed by a pint of water. A shadow of the gall bladder was obtained after six hours, which at the twelfth hour became more pronounced. The dye was accordingly given to seven house officers at the Peter Bent Brigham Hospital, Boston. This experiment was attended by considerable success, six of the seven cases exhibiting clear visualization of the gall bladder. Since this work of Whitaker, *et al.*, the oral method has become a routine procedure in the offices of many roentgenologists. Because the dye is irritating to the stomach, and an insoluble free acid is formed by the hydrochloric acid of the gastric juice, the necessity for getting it through without coming in direct contact with the stomach was recognized. This could best be accomplished by administering it in pill or capsule form with enteric coating, and the writers, like many others, tried different varieties. At first, the best results were achieved with capsules that were exposed to formaldehyde fumes, carrying out the suggestion of Menees and Robinson. In

a number of cases, however, it was noted that the capsules did not break down but passed through the stomach, seemingly intact. The products of several pharmaceutical houses, in the forms of capsules and pills, were tried for comparative purposes and the percentage of absorption was smaller with each manufactured product than with the formalin-hardened capsules. We, therefore, carried out a few simple experiments with the hope of securing some type of protected capsule which would allow of better absorption of the dye, the interference with which is largely due to a chemical reaction. Tetraiodophenolphthalein sodium salt is very readily soluble in water, but in the presence of mineral acid, such as hydrochloric, the free acid of the tetraiodo is formed, which appears as a white sediment, and this is highly insoluble in water. If the sodium salt is given directly into the stomach, the acid gastric juice immediately converts the salt to the insoluble free acid. If this free acid passes on into the intestines, the alkalinity of the intestinal fluid is not sufficient to convert the free acid to the soluble salt again; consequently, the desired results could not be obtained. Menees and Robinson mentioned precipitation of the dye by inward diffusion of the acid into the capsule and to prevent this made a thin paste of the dye with olive oil. We were unable to obtain satisfactory results by that method.

EXPERIMENT I

Ordinary gelatin capsules, each containing 0.5 gram of tetraiodo, were immersed in 30 c.c. of gastric juice. The capsules began to swell almost immediately and within fifteen minutes HCl had penetrated them and come in contact with the dye. They were almost completely digested in two hours. A film of free acid in the nature of a white sediment formed around the periphery of the dye, which retained the general form of the capsules, quite hard in consistency. The gastric juice was then drained off and 30 c.c. of duodenal contents added. The dye disintegrated within five minutes in the intestinal fluid and that portion which had not been converted to the free acid readily went into solution. The free acid, however, did not, even after standing over night in the duodenal contents. It is apparent that the alkalinity of the intestinal fluid is not sufficient to dissolve the free acid of the dye.

EXPERIMENT II

This was carried out the same as Experiment I, except that double walled ordinary capsules were used. These were prepared by filling No. 0 capsules with the dye and enclosing them in 00. The outer ones started to swell immediately after immersion and were almost completely digested by the gastric juice in two hours. There was considerable penetration into the inner, but they were not digested. The amount of white sediment precipitated out in the intestinal fluid was less than with the single walled capsule, indicating that more of the soluble dye was unaffected by the action of the HCl and available for absorption.

EXPERIMENT III

Keratin-coated capsules containing tetraiodo, like the plain capsules, began to swell almost immediately after immersion in gastric juice. The HCl penetrated them in thirty minutes and came in contact with the dye, but they were not as completely digested at the end of two hours as were the untreated capsules. Less of the dye was converted into the free acid and slightly more of the unaffected dye went into solution in duodenal contents than in either the single or double walled ordinary capsules.

EXPERIMENT IV

Capsules were hardened by exposure to formalin fumes for varying lengths of time, from one-half to nine hours. They began to swell within five minutes in the gastric juice and penetration by the acid was discernible in three-quarters of an hour. They were incompletely digested in two hours, and only partially broken down even after

remaining twenty-four hours in the duodenal contents, some of the dye going into solution and some failing to do so. In capsules that were hardened sufficiently to remain intact in the gastric juice for four hours, there was no penetration by the HCl, but they were absolutely unchanged after twenty-four hours in intestinal fluid.

EXPERIMENT V

Untreated double capsules, except that the spaces between them were filled with sodium bicarbonate, were used, the outer ones being large enough to contain a sufficient amount of the soda to completely cover the inner capsules. These began to swell very shortly after being placed in gastric juice. After two hours the outer capsules were not quite digested and only the very slightest penetration of the inner was perceptible. Scarcely any of the dye was converted into free acid, the HCl of the gastric juice being used up by the sodium bicarbonate, which adhered rather tenaciously to the inner capsule. These remained quite intact. They disintegrated readily in the duodenal contents and only faint traces of the white sediment were left, the greater portion of the dye going into solution.

To summarize these experiments:

Our series of cases show that a greater number of gall bladders are visualized, fewer capsules pass through the intestinal tract undigested and absorption of a greater amount of dye takes place by the use of double plain capsules, the inner containing dye protected by an intermediary layer of sodium bicarbonate, than by single or double untreated, keratin-coated, or formalinized capsules. The following are the results obtained, utilizing four types of capsules, given to one hundred and sixty patients, divided into four groups of forty each:

Group I: Ordinary double capsules containing 0.25 gram of tetraiodo. Gall-bladder outlines were clearly visible in thirteen cases. No shadows were obtained in twenty-seven cases. In fifteen instances, the dye was not broken down and maintained the capsular form in the large bowel. In twelve instances, the dye was scattered through the bowels and if any absorption had occurred it was insufficient to produce shadows of the gall bladder. Visualization occurred in 32.5 per cent of cases.

Group II: Keratin-coated capsules. Gall bladders were delineated in twenty-two cases. No visualization in eighteen. In ten, the dye retained the capsular form with none broken down. In eight, the dye retained capsular form and some was broken down and scattered through the bowel. Visualization occurred in 55 per cent of the cases.

Group III: Formalin-exposed capsules. Twenty-seven gall bladders were visualized. Thirteen failed to show. In all of the cases, a substantial amount of the dye was unabsorbed. In the thirteen cases in which no shadows were obtainable, all of the capsules were apparently intact in eight, and in five there was a combination of intact and broken down capsules. Visualization was positive in 57.5 per cent of the cases.

Group IV: Double capsules with sodium bicarbonate between the inner and outer. Visualization occurred thirty-four times. No positive shadows, six times. In only three of the thirty-four visualized cases could there be seen any of the unabsorbed dye. In the six which failed to cast shadows, none of the dye retained capsular form but was diffused throughout the large intestines. Gall bladder demonstrated in 85 per cent.

In only twelve of the one hundred and sixty patients to whom the dye was given, did vomiting occur. Twenty-two were nauseated, but slightly. A mild diarrhea occurred in all but twenty and many of the patients requested a supply of the capsules because of their excellent laxative qualities.

Much of the success in obtaining gall-bladder shadows depends upon preparing

Fig. 7. Note distance of dye-filled gall bladder from spine; evidence of normal variation in position.

Fig. 8. Gallstones. The dye failed to visualize the gall bladder.

Fig. 9. Gallstone in visualized gall bladder.

the intestinal tract in order to obtain the best possible conditions for absorption of the dye. This is almost imperative. We advise one to two ounces of castor oil two nights before administering any dye. On the day previous to the examination, liquid diet is prescribed and No. 3 capsules containing 0.25 gm. of tetraiodo enclosed in No. 0 capsules which contain enough of the sodium bicarbonate to completely surround the dye-containing capsules are given, three every half-hour beginning one hour after a supper consisting of cereal, toast and tea. Twelve are given (gm. 3) to patients up to 150 pounds, fifteen (gm. 3.75) up to 164 pounds, and eighteen (gm. 4.5) up to 200 pounds. A glassful of water, to which has been added gm. 2 of sodium bicarbonate, drunk at frequent intervals during the taking of the capsules, tends to reduce slightly the gastric acidity and thereby offers additional protection.

Very few patients object to the restriction to a liquid diet for a day and abstaining from breakfast on the morning of the examination. They present themselves at the fourteenth hour, when studies are made, also from two to four hours after being permitted to partake of food rich in fats; at the twenty-fourth, thirty-sixth and forty-eighth hours, and even subsequent to that if the gall-bladder shadow persists.

Sabatini and Milani, of Rome, recently reported "remarkable results" in showing the gall bladder by means of strontium and sodium bromide, 10 to 20 grams being given by mouth. They state that the gall-bladder shadow is frequently noted after five hours. They are so encouraged as to feel that the bromides will "replace other means which have been recently suggested to accomplish the same thing."

The writers tried this method, following closely the technic suggested, but were unable to obtain any vestige of a gall-bladder shadow in twelve normal individuals.

The utmost conservatism must be exercised in the interpretation of the cholecystograms. Findings, in order to be of value, must be corroborated by operation and microscopic study of the specimens.

It is interesting to observe the size, shape and position of the gall bladder in different individuals. Most textbooks on anatomy describe it as about three inches long and one and one-fourth inch in diameter and as generally being pear-shaped with its fundus lying near the end of the ninth costal cartilage. Cholecystography reveals marked variations from the usual anatomi-

Fig. 10. Enlarged gall bladder. Note dye in cystic duct.

Fig. 11. Large hour-glass gall bladder, likely due to band of adhesions.

cal descriptions. It is seen to be from one to five inches in length and from one to three inches in diameter. It is oval, globular, pear-shaped or crescentic. It has a wide range of mobility and may be seen near the ninth costal cartilage or not infrequently the fundus is below the iliac crest level, or may occupy any position between. Its inner border may approximate the spine or be several inches distant. The size of the liver is readily distinguishable, as also its contour, of great value in diagnosis.

The most positive evidence of pathology is, of course, the recognition of calculi. In many cases in which stones are not demonstrable on films preliminary to administration of the dye, they are nicely shown as negative shadows in the dye-filled gall bladder. In a recent case, however, a stone was clearly visible on the plain film but not on the film on which the dye-filled gall bladder was distinctly outlined, the admixture of the tetraiodo and bile in this instance obscuring the shadow of the stone. Mottling which appears to be in the gall bladder may be due to stones or diseased walls, but one must be certain that this mottling is in the gall bladder itself. We have seen cases where projections in oblique and lateral positions convinced us that the mottled shadows which at first seemed to be in the gall bladder were entirely outside.

Caldwell said—and it still holds true—"It is very easy to make a roentgen diagnosis of gallstones. The difficult thing at present is to avoid making such a diagnosis occasionally when no stones are present." He strongly opposed such diagnoses on indefinite shadows and stressed the fact that if a sufficient number of plates were made, suspicious shadows would be detectable in all normals.

Deformities of the dye-filled gall bladder are, in our opinion, the next most positive sign of pathology, having almost as much significance as a deformed duodenal cap in the diagnosis of ulcer, cancer, adhesions, etc. Such deformities may be due to adhesions or extrinsic or intrinsic pressure of neoplasm. Restricted mobility is an indication of adhesions. If a film taken during deep inspiration does not show the gall bladder in a lower position than one taken during expiration, its loss of mobility suggests adhesions to the anterior abdominal wall.

Some writers feel that failure of the dye-filled gall bladder to empty within thirty-six hours is indicative of pathology. Two

cases in our series in which the dye was present for longer than forty-eight hours and in which the size of the gall bladder was only slightly smaller than at the fourteenth hour were declared by the surgeon who operated on both to have perfectly normal gall bladders. We are rather guarded at this time in reporting pathology on variations in emptying time alone.

We would suggest always screening the chest in patients whose visualized gall bladders fail to empty in thirty-six hours, with particular reference to diminished diaphragmatic excursion. If the excursion of the right diaphragm is markedly restricted, its pressure on the liver is lessened, which may play an important rôle in altering the emptying time of the gall bladder. Also, pressure on the common duct by gas in the duodenum may be a possible factor in producing some obstruction of the duct, thereby influencing gall-bladder evacuation.

In thirty-seven of the above series of cases, a diagnosis of gall-bladder disease was made, but only six have come to operation. In two, so-called delayed emptying time gave no evidence of pathology at operation. In two that failed to fill even after the test had been made twice, gallstones were found. These were demonstrable on the films before and after the dye. In one case in which the gall bladder filled readily and was empty at the twenty-fourth hour, a large stone was found. This stone was seen on both the preliminary film and the cholecystogram. One case in which the gall bladder failed to fill and in which a duodenal ulcer was present showed dense adhesions between the duodenum and the gall bladder.

CONCLUSIONS

By means of the Graham-Cole test much valuable information regarding the anatomy and physiology of the liver and gall bladder will be disclosed, just as the demonstration of the bismuth-filled gastro-intestinal tract has given us accurate facts concerning its anatomy and physiology in the living subject.

The oral method has the distinct advantage of simplicity and none of the dangers of the intravenous.

Examinations in doubtful cases may be easily repeated.

Diagnostic inferences may be drawn, similarly to the visualization produced by the intravenous method.

The diagnosis of cholecystic disease should not be made merely on marked variations of emptying time and mottled appearance of the gall bladder, until after large numbers of operative and pathologic reports establish their significance. Accurate interpretation of visualization and non-visualization will be attained only after collaboration between pathologist, roentgenologist and surgeon.

The chief purpose of this presentation is to show what, to us, has proved the best and simplest method of administering the dye orally, eliminating the uncertainties in the use of chemically hardened capsules, affording the greatest degree of protection against the acid of the gastric juice, and making available for absorption the largest amount of dye. This was accomplished when the dye was given in No. 3 plain capsules which were inserted in No. 0, the outer containing sodium bicarbonate, and they proved superior to any other forms used, offering the highest percentage of visualized gall bladders.

The tetraiodo used in this work was shown by test to be of the highest purity, the product of the National Aniline Company, to whom we wish to express our indebtedness for their willing co-operation and assistance. The dye is put up in one ounce brown bottles as a protection against light and deterioration by ageing. It is recommended that the capsules be prepared freshly a short time before their administration.

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DISCUSSION

DR. H. J. ULLMANN (Santa Barbara, California): We went through very much the same trouble that Dr. Levyn did in finding a satisfactory oral method. We gave enteric-coated pills, put out by a manufacturer with very nice advertising literature, as they generally have. Fortunately I tried them on myself and assistants first, and two out of three had diarrhea. One had vomiting and the other's gall bladder did not fill at all. This individual whose bladder did not fill, had filled intravenously, and had filled on the formalin-hardened capsules after the method of Menees. Menees recommends a rather thin paste of the dye, made with olive oil. His theory is that the oil protects the dye from the gastric juice in the same way the bicarbonate does. I think we should not compare the use of the hardened capsules without the oil with any other method to the detriment of the Menees method. We should use the oil as he specifies before criticizing it. We have had a higher percentage of visualization of the gall bladder by that method than Dr. Levyn has had. I cannot give you the figures, but one thing is essential; if the gall bladder does not fill the first time, you must repeat after catharsis. I have quite a number of patients sent to me for gall-bladder examination who also have colitis. We and our internists are very much opposed to the routine giving of cathartics. One man said it took him two weeks to get over a cathartic we had used, so we give the dye without any preparation to start with, and then if the gall bladder does not visualize, we give compound licorice powder, and twenty-four hours later we give the capsules again, and, except in the case of pathological gall bladders, they are usually visualized. You must use the capsules soon after they are hardened; if they stand ten days or a week they will be found undissolved in the colon. They must be freshly hardened, and that is a definite objection. I was very much impressed with Dr. Levyn's results with double capsules and we are going to try them. It sounds better than the formalin-hardened capsule method, although we have had better results with them than Dr. Levyn had.

DR. JOHN D. CAMP (Boston): The oral method of administration has been of considerable interest to us at the Massachusetts

General Hospital. We have, up to the present time, examined about two hundred and fifty cases by this method. Our first experiences with the various commercial products and also the formalin-hardened capsules were very unsatisfactory. I do not say that the commercial products at the present time have not been improved; I think they have. However, we were unable to secure satisfactory shadows with these methods, and, in more or less desperation, we were driven to some sort of method that could be used on our out-patients, because at the present time we feel that it is unsatisfactory to subject patients to the intravenous method and send them home to be left to the care of someone else. There is a certain amount of risk attached to the intravenous method, which we do not like to pass on to someone else.

We have examined about sixty patients, using the Menees method, although we have not used the oil preparation. We found that so many of those capsules failed to dissolve that the shadows were of very doubtful value, and if we gave patients five capsules containing a gram of dye, we frequently found four of them undissolved. We tried varying degrees of hardness, with about the same results, and at the suggestion of Dr. Carman we tried using the plain gelatine capsules.

The essayist has made the point that if the drug be given in a plain capsule, it will be precipitated in the stomach and will not dissolve when it reaches the alkali in the small bowel,—a certain amount of which is true. However, we have examined about a hundred and seventy-five patients with the plain gelatine capsules and have had excellent results with them. We have been correct in about 91 per cent of the cases, which I think is a good percentage. The shadows we have been able to obtain with this method have been more satisfactory than those secured by any other oral method so far; so, if some of the drug is precipitated in the stomach, I do not believe that the amount precipitated is sufficient to interfere with the value of the test.

As regards the reaction we have experienced in using this method, I will say that 45 to 50 per cent of our patients have had more or less nausea, and about 30 per cent have experienced vomiting of more or less degree. This is probably higher than many of the men have experienced; I know that from talking to many of them. Now, the percentage of reaction is interesting, because, when we used the formalin-hardened capsules—I do not remember the figures exactly, but nearly 30 per cent of the patients had nausea and vomiting. So I do not think the whole thing can be blamed on the fact that the dye produces an irritation in the stomach. I do not think, however, that this is the ideal method; we may have to go back to the coated capsules, which I am willing to do if it offers any advantage.

DR. SHERWOOD MOORE (St. Louis): I regret very much that I did not hear the essayist's full paper, but I can not refrain from paying my tribute to the exquisite work that he has shown. I wish that I could do it as well as he has; I never saw such beautiful work as he has put here on the screen. Now our conception of cholecystography is that it is a measure of the functional capacity of the gall bladder. For that reason we think, for the sake of accuracy in making the test, that the intravenous is the method of choice. In that we may be wrong. I do not know; we prefer it and that is our method of carrying out this procedure. A known quantity of dye is put into the circulation and one can appraise the result much better if there are known factors. I wish very much that the oral could be developed so that it would be as sure a method as is the intravenous. I would disagree with Dr. Camp; I believe cholecystography is entirely safe, and we have had the cases to prove it, on the walking patient. We have had many of them from our dispensary and we carry it out almost daily.

DR. JACQUES FORESTIER (Aix-les-Bains, France): I will take the opportunity afforded by the remarkable paper which has just been read to show two or three slides illustrating a method which does not conflict with cholecystography, but is an addition to it, for surgical cases. Where there is a fistula, or in a case already subjected to cholecystectomy, it is of advantage sometimes for the surgeon to know where the bile is coming from and what are the connections of the wound with the bile ducts. In such cases one may inject lipiodol easily through the fistula and demonstrate the shapes of the bile ducts, and this is of some importance. This is a case [showing slide] of fistulized cyst of the liver, and you see that by means of the fistula injection the cyst, the gall bladder, and the ducts are demonstrated. This method is sometimes of use to the surgeon, but there is another condition under which lipiodol may be of very great value: when, after cholecystectomy, there is some elimination of the bile through the drain and a possible obstruction. In the case shown [on this slide], Dr. Cotte, of Lyons, France, had operated for chronic cholecystitis. He had explored down to the pancreas, had seen no gallstones, had performed cholecystectomy, but in spite of that the patient was not doing well, and sometimes there was jaundice. It was suggested that there was an obstruction which had not been seen at the time of the operation. The surgeon first tried to inject a solution of sodium iodide through the drain, but this did not give any diagnostic results, and the patient developed toxic symptoms. He had fever, a rise in temperature, an increase of jaundice, and signs of auto-intoxication. In a second attempt, the surgeon tried the use of lipiodol. The injection was made easily. You see (Fig. 1) the bile ducts, the dilatation of the common

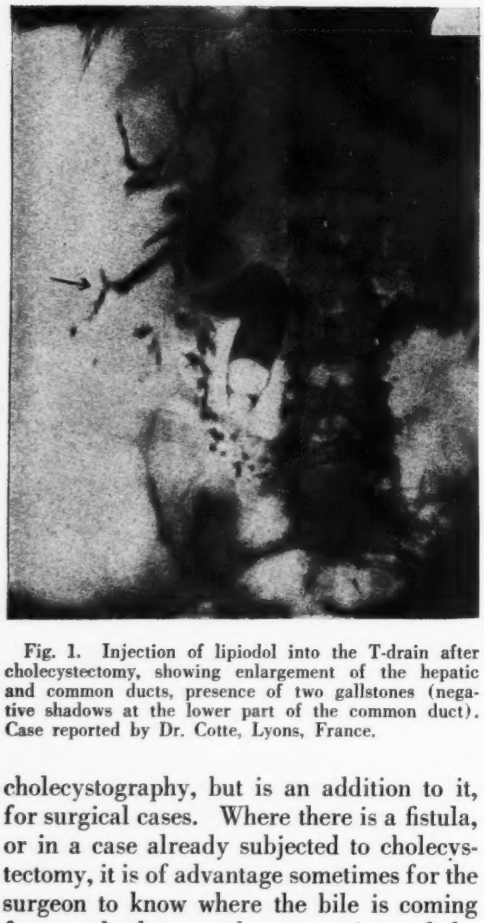

Fig. 1. Injection of lipiodol into the T-drain after cholecystectomy, showing enlargement of the hepatic and common ducts, presence of two gallstones (negative shadows at the lower part of the common duct). Case reported by Dr. Cotte, Lyons, France.

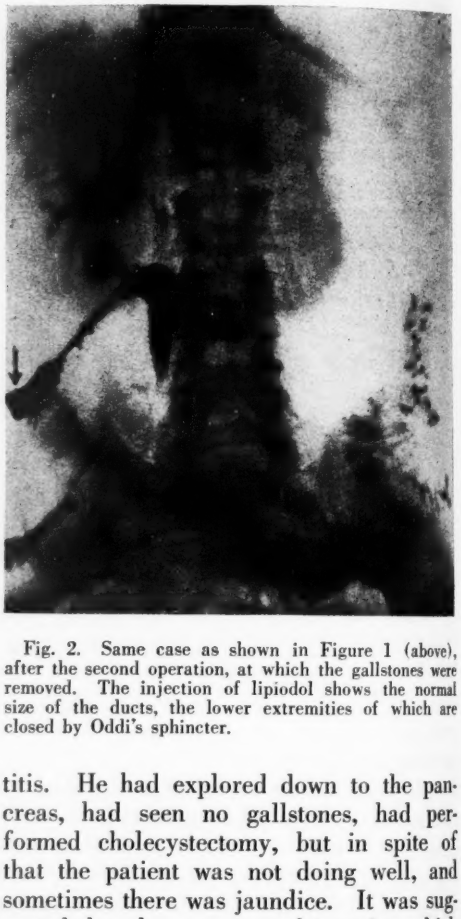

Fig. 2. Same case as shown in Figure 1 (above), after the second operation, at which the gallstones were removed. The injection of lipiodol shows the normal size of the ducts, the lower extremities of which are closed by Oddi's sphincter.

duct, and a negative shadow cast by two stones which had not been found at operation. Dr. Cotte operated a second time, finding the two gallstones, and made a second injection of lipiodol as a test of the patency of the ducts. In Figure 2 you see that the common duct is by no means as broad as before, and here and there some irregular shadows prove that the lipiodol has passed into the intestine.

I wish only to emphasize the point that after the operation of cholecystectomy, it would be a very good routine procedure to make a test of the patency of the tubes by means of lipiodol. I think this is a modest addition to the wonderful method of cholecystography devised by Dr. Graham and his associates, and I wish to pay them my tribute of admiration.

Dr. James T. Case (Battle Creek, Mich.): I want to thank Dr. Forestier for his demonstration. I had the pleasure of seeing one of these illustrations of a common duct fistula injection in the journal of one of the French societies, and I have used the method several times myself. I have in mind particularly one case where a common duct obstruction was operated upon, and, to my dismay, after the operation, no bile went into the intestines; it all came out through the tube. I had considerable apprehension until I used lipiodol and found that it passed with perfect ease into the duodenum: so I am resting easier and the patient is very happy.

I want to say, with reference to the work of the essayist, that he certainly deserves credit for the careful experiments he has undertaken, quite aside from the old topic of what is the best form in which to give the dye—by the oral or intravenous method. I want to add my own testimonial that the intravenous method is a perfectly safe routine procedure for the office, ambulatory and out-patient department. I have now, with my associates, done nearly six hundred cases in the office, all by the injection method. We have not had to chase them or send any doctor out to take care of any of these patients in their homes.

My technic is, perhaps, a little different from any which I have heard discussed. We give our injections, not in the morning, but at five in the afternoon. We do the injecting at one sitting. All the dye is out into the vein within three or four minutes. We use three and a half grams for the average patient. We put it in, together with about 75 to 100 c.c. of Ringer's solution, so it goes into the veins quite diluted, but we put it all in within three or four minutes. The patients are then kept lying down on a couch for from fifteen to thirty minutes, after which they are allowed to go home.

I want to tell you that the percentage of reaction, nausea, vomiting, and even headache or distress which follows these injections is a great deal less than the 40 or 50 per cent which is admitted by some of our colleagues who prefer the oral method. We have not had any patients complain of diarrhea, and not over 2 or 3 per cent have vomited. We can nearly always tell ahead of time which patients are going to have reaction, by sizing them up. If the patient is of the neurasthenic, highly excitable type, we anticipate a little trouble.

We do the injection at five in the afternoon; the patient goes on a pure carbohydrate supper; next morning he comes at eight o'clock—before breakfast—for two X-ray films. He is then instructed to eat a breakfast including egg yolk or milk and cream. He comes back at eleven-thirty to twelve and we make two more films, and that concludes the examination.

Dr. Levyn (closing): Regarding the administration of the dye in the form of a thin paste made with olive oil, as used by Menees and Robinson: We have tried this method but were not nearly so successful as with the plain formalin-hardened capsules without any treatment of the dye itself. We have been informed recently that Menees and Robinson have since abandoned

that method and have gone back to the hardened capsules.

We wish to mention briefly two points that will prove of diagnostic value. First, that all patients subjected to cholecystography should have their chests screened, because restricted diaphragmatic excursion causes diminished pressure on the liver during inspiration, thereby mechanically delaying the emptying time of the gall bladder. Second, that it is possible at times to demonstrate adhesions between the gall bladder and the anterior abdominal wall. If the position of the gall bladder is the same after deep inspiration as after expiration, we would assume that it is fixed, probably to the abdominal wall, because, normally, the gall bladder will be seen considerably lower after deep inspiration than following expiration.

Experimental tumors. — There is no evidence that the very infrequent spontaneous regressions of human tumors are due to any process of immunization. There is also no evidence that the similar spontaneous disappearance of primary animal tumors is due to any process of immunization. The spontaneous regressions, so often observed in transplanted animal tumors, are an entirely different phenomenon. The tumor is a graft into a healthy host and hence is not perfectly adapted to the soil. There is no cogent evidence for, and much against, the conclusion that any process of immunization aids in the therapeutic efficacy of irradiation.

W. W. WASSON, M.D.

Immunity in Cancer. Francis Carter Wood. Jour. Am. Med. Assn., Oct. 3, 1925, p. 1039.

Implantation of thorium X seeds.—In the Institute for Cancer Research in the University of Berlin, Thorium X (on account of lack of radium) was used instead of the radon seeds employed in this country for implantation into malignant growths. Thorium is physically very closely related to radium; it was made insoluble with the barium sulphate and mixed with a paste and formed in thin elastic rods. Instruments similar to the inserter used here for the implantation of glass capillaries were designed. Cancer of the skin, mouth, tongue, sinuses, and recurrent tumors of the breast were treated with this method and gave satisfactory results; even the malignant roentgen carcinoma yielded to this treatment. The observation covers a period of two years.

E. A. POHLE, M.D.

The Use of Thorium X Bacilli for Implantation in Tumors. L. Halberstaedter and A. Simons. Strahlentherapie, 1925, XX, 268.

X-ray examination for calculi.—The author reviews the varying results of chemical analyses of urinary calculi by various investigators. He emphasizes the fact that calculi containing large percentages of uric acid, urates and triple phosphates are apt not to show on roentgen-ray examination, as a corollary to which fact is the conclusion that all other means as well as radiography should be used to establish a negative diagnosis in cases where clinical grounds for suspicion of the presence of calculi exists.

CHARLES D. ENFIELD, M.D.

Urinary Calculi. Daniel E. Shea. Jour. Am. Med. Assn., Dec. 19, 1925, p. 1939.

Chronic cicatrizing perinephritis.—Perirenal sclerosis, better called "chronic cicatrizing perinephritis," may evidence itself at a considerable period after an acute perirenal infection. The only symptoms may be a persistent pain in the affected kidney and a deficiency of urinary elimination from this organ. Nephrolysis, or decapsulation, relieved all pain in the two patients under discussion, and there was ultimately a complete return to normal function on the affected side.

The pathology of this condition represents a replacement of the fibrous and fatty capsules of the kidney by a dense, fibrous cicatricial shell which contains evidence of a persistent low-grade interstitial infection. The cicatricial contraction about an otherwise apparently normal kidney must have been the cause of pain and lowered renal function in these two cases.

W. W. WASSON, M.D.

Perirenal Sclerosis (Chronic Cicatrizing Perinephritis): Reports of Two Cases Occurring as a Sequel to Perinephritic Abscess. Vincent J. O'Conor. Jour. Am. Med. Assn., Oct. 10, 1925, p. 1118.

ROENTGEN-RAY EXAMINATION OF THE JOINTS OF HEMOPHILICS [1]

By HOWARD P. DOUB, M.D., and EDWARD C. DAVIDSON, M.D., from the Departments of Roentgenology and Surgery, Henry Ford Hospital, DETROIT, MICHIGAN

HEMOPHILIA is an hereditary abnormality of the blood or blood-forming organs which occurs only in males, but is transmitted by females alone. It is characterized by a deficiency of prothrombin in the blood, which results in a delayed coagulation time and a liability to immoderate hemorrhage. There is an extensive literature on this interesting condition, but it has been practically limited to the hereditary nature of the malady or to the alterations found in the blood. The changes from hemorrhage into the joints of such individuals have received slight attention.

The first mention of a disease resembling hemophilia in any way is found in the writings of Albucasis (1). He reported that in a certain village there were men who, when wounded, suffered uncontrollable hemorrhage which caused death. Knowledge of the existence of the disease as a distinct clinical entity did not become general until after the publication in 1803 by Dr. John C. Otto (2) of "An Account of the Hemorrhagic Disposition Existing in Certain Families." He stated that only males are affected and all are not liable to it; though females are free from the disease they are capable of transmitting it to their children. This paper attracted immediate attention and a great many cases were promptly reported.

In 1820 Nasse (3) stated what has since become known as Nasse's law—although previous writers had emphasized the fact that "Males alone are subjects of hemophilia and the disease is transmitted by normal females through their marriage with normal males." There has been a great deal of confusion in the literature about the various hemorrhagic diatheses. Much was accomplished by Bullock and Fildes (4) to clear the situation. They critically reviewed all of the reported cases and showed conclusively that no unequivocal case had ever been reported in a female and no true transmission had ever been observed through an affected male.

The more recent investigations have been concerned chiefly with the pathology of the blood. Wright (5) demonstrated that there was a retardation of the clotting time and pointed out the shortening of the coagulation time following severe hemorrhage. He attributed this to a diminution of blood calcium. Weil (6) attributed the prolonged coagulation time to an excess of anticoagulating material present. Addis (7) reported that the coagulation time may vary from day to day and he attributed this to a qualitative defect in the prothrombin. Morawitz and Lossen (8), and Sahli (9) stated that the fundamental defect was an inadequate amount of thrombokinase in the blood and tissues in general. Howell (10) concluded that the deficiency in prothrombin was quantitative rather than qualitative. Minot and Lee (11) have clearly shown that the platelets of hemophilic blood, though present in normal numbers, are only slowly available for their normal functions. It would seem that a prothrombin deficiency alone is responsible for the prolonged coagulation time.

RESUME OF LITERATURE OF JOINT INVOLVEMENT

Escande and Tapie (12) report a case occurring in a child aged nine years. Both knees were the seat of recurrent attacks of hemarthrosis. They describe the roentgenological changes as consisting of marked osteoporosis of the epiphyses but not extending to the diaphyses, alteration of the articulating surfaces of the bones without the production of osteophytes, diminution

[1] Read before the Radiological Society of North America, at Cleveland, Dec., 1925.

of the interarticular space, and increase in the size of the patella. They are led to the conclusion that types described by different authors are only different stages of the same process, beginning with hemarthrosis, progressing through panarthritis to deformity of the joint.

Petersen (13) reports four cases of this type, three of whom showed changes in the hip joint. He describes pathological changes occurring not only in the articular cartilage but also in the head of the bone. Some band-like shadows were seen in the joint outside of the bone. These findings suggest that the disease may be caused by hemorrhage in the synovial sac. He thinks that hemorrhages also occur into the bony substance. There may be two kinds, one in which the hemorrhage occurs in the joint and the other where it occurs mainly in the bone.

Youmans (14) in reporting a case of hemarthrosis in a child of ten, refers to two other brothers who had also had recurring attacks. In one of these the knee was aspirated and a large quantity of clotted blood removed. He describes the roentgen-ray findings as follows: (1) No atrophy; (2) no erosion of bone; (3) the distended capsule filled with blood; (4) thickening of the capsular membrane. The chief interest in this group is the restriction of the symptoms to joint involvement and the lack of deformity resulting, in the case described. This, however, is probably due to the shortness of time intervening since the first attack.

The usual course and symptoms in hemarthrosis are described by Wilson (15) in reporting one case. The joints are hot, tender, not red, stiff, and extremely painful. There is usually fever between 102° and 103°, with extreme prostration. After about ten days the local and constitutional symptoms abate, the effusion is absorbed, leaving a normal joint or one with some stiffness or even deformity, if it is the result of repeated attacks. The roentgen-ray findings are stated to have been fibrous tissue production in the joints due to repeated attacks. In the older brother of the above mentioned patients, the joints showed chronic hypertrophic arthritic resemblance.

One case of knee-joint involvement is reported by Roth (16). This was in a boy aged six and one-half years, who had had repeated hemorrhages in the right knee since the age of three. He reports the roentgenograms as showing extensive absorption of the cartilage and articular surfaces of the bones, with new bone formation in the form of lipping. There was also a shadow around the joint, apparently due to distention of the synovial cavity with blood.

Klason (17), in reporting three cases, states that there is seen in the early stages a cloudiness of the capsule from blood clots, and later decalcification with alteration of the cartilages and deformities, resulting in a hypertrophic arthritis deformans.

Baetjer and Waters (18) give an excellent description of the changes in the advanced cases. They describe gouged-out areas extending through the cartilage into the bone. In some cases there may be complete destruction of the articular surface, and a blood clot in the synovial cavity which may become organized and even show some calcification.

McLean (19), in describing the joint changes, states that the synovial membrane becomes roughened and hypertrophied and may show gouged-out areas extending from the articular surfaces into the epiphysis. In some cases the hemorrhage is into the epiphysis or diaphysis, leaving the articular surface intact.

We have had the opportunity to observe the joints of two hemophilics at the time of acute hemorrhage. In each instance the joint was aspirated, confirming the diagnosis of hemarthrosis. The one was a member of a family in which the disease was traced through four generations. The other was a child, and as far as could be determined there was no history of bleeding ex-

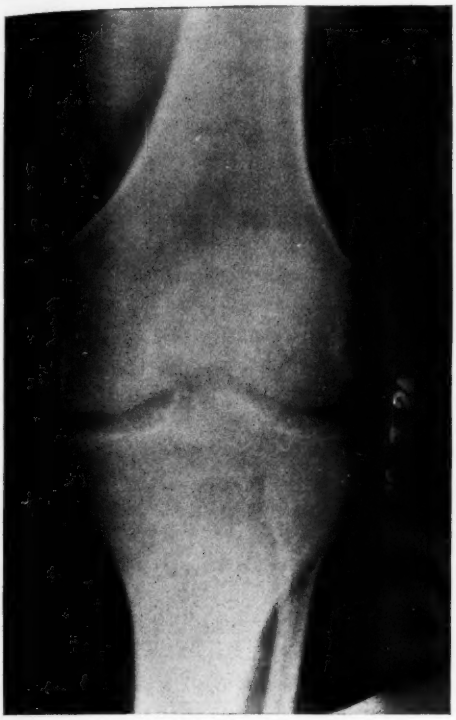

Fig. 1, Case 1. Deformities similar to those seen in chronic infectious arthritis. The soft tissue changes were too indistinct for reproduction.

cept in one maternal uncle and in the patient's brother, who died from hemorrhage following tonsillectomy. The remaining five cases demonstrate the joint alterations which occur following repeated hemorrhages. Three of these are members of a family in which the disease has been traced through eight generations. Another is in an individual who gave a negative family history of a tendency to bleed, but blood studies were convincing that he belonged to this group. The last case is in an individual who could give no history of his antecedents.

CASE HISTORIES

Case 1. S. G. (Hosp. No. 50742), white male, Jew, aged twenty-two years, was admitted to the hospital on October 6, 1924, complaining of swelling and pain in the left knee.

Family history (20): Two great uncles on the maternal side bled to death in early childhood from minor injuries. One maternal uncle bled to death following circumcision at the age of eight days. One maternal uncle bled to death following a slight trauma at the age of fourteen years. Another maternal uncle is a known bleeder and is alive at the age of forty-five years. A maternal male cousin bled to death at the age of eight days following circumcision. Another maternal cousin at the age of seventeen years was struck on the nose with a book and died of epistaxis.

Past history: During early childhood the patient experienced frequent minor injuries but hemorrhage was never excessive until after the age of six years. At this time he fell and bit his tongue. Bleeding persisted for ten days and was finally controlled by suturing the tongue, although the original laceration did not appear sufficiently extensive to warrant this measure. At the age of seven years he bled for two weeks following the extraction of a tooth. At the age of twelve years his right tibia was fractured. There was serious hemorrhage, but healing finally took place.

Present illness: Seven years previously the left knee became swollen and painful. This was not accompanied by chills, fever, sweats or loss of weight. No other joints were involved and the symptoms persisted for about ten days. There have been frequent recurrences of this course of events, with complete functional and symptomatic recovery during the intervals. On a few occasions the swelling has followed injuries. The present attack came on abruptly, during the night, two days previous to admission.

Physical examination: The general examination was essentially negative. The left knee revealed marked synovial swelling, but there was no redness. There was an effusion present. The local temperature was elevated. The joint capsule was tense and quite tender. All normal motion was prevented by muscle spasm and no abnormal mobility was determined.

Fig. 2, Case 2. No bone destruction. Calcified hematomata. Marked effusion into the joint.

Laboratory examination:

Red blood cells	4,660,000 per c.mm.
White blood cells	14,000 " "
Hemoglobin	83 per cent
P.M.N.	78 " "
P.M.B.	1 " "
S.M.	15 " "
L.M.	6 " "
Blood Wassermann	Negative
Coagulation time	No clot in 65 minutes
Urine examination	Negative

The knee was aspirated and 25 cubic centimeters of blood were removed.

Roentgen-ray findings: Examination of the left knee revealed an effusion in the joint, with distention of the capsule. The joint surfaces were roughened and there was some lipping present. There were several small areas suggesting calcification in the capsule of the joint.

Case 2. A. A. (Hosp. No. 25388), a white boy, aged six years, entered the hospital September 5, 1923, complaining of swelling and pain in the left knee.

Family history: The patient's maternal uncle was a bleeder. A brother of the patient died from hemorrhage following tonsillectomy.

Past history: The child was known to bleed immoderately following a slight trauma. In January, 1924, a mastoidectomy was done for acute mastoiditis. Bleeding persisted for ten days, during which time two blood transfusions were given. The blood platelet count at this time was 354,000 per cubic millimeter.

Present illness: Six weeks previous to admission the child struck his left knee, which became tender and quite swollen. Moderate pain persisted.

Physical examination: The findings in the general examination were unessential. The left knee was held in a position of sixty-five degrees of flexion. There was marked swelling, and elevation of the local temperature. There was generalized tenderness and the leg was more or less fixed by muscle spasm.

Clinical course: The child did not react to one-tenth of a milligram of old tuberculin. On September 7, 1925, the knee was aspirated and a few cubic centimeters of partially hemolyzed blood were removed. This material was injected into a guinea pig. Subsequent autopsy of the animal revealed no evidence of tuberculosis.

Roentgen-ray examination: Films of the left knee showed a large collection of fluid, but no hazing of the joint surfaces. There were several irregular areas of calcification over the anterior surface of the lower end of the femur suggesting calcified hematomata. There was no bone or cartilaginous destruction.

COMMENT

In Cases 1 and 2 the patients were seen at the time of acute hemorrhage into the knee joint. The diagnosis of hemarthrosis was verified in each instance by aspiration of the joint. The roentgen-ray examination

of Case 2 was of particular interest because there was no history of any similar previous attack. There was evidence of a large collection of fluid, but the joint surface was intact. Despite the negative history there were observed several areas of calcification over the anterior surface of the lower end of the femur which suggested calcified hematomata. In the first individual, who had had a number of similar previous experiences, the joint capsule was also distended, but in addition revealed small areas suggesting calcification. Unlike Case 2, the joint surface showed some roughening and there was slight but definite lipping. Neither of these cases, which from the X-ray point of view are still early, revealed any bone destruction. The characteristic lesion in such cases is calcification of hematomata and articular changes quite similar to a case of hypertrophic arthritis.

Case 3. R. T. R. (Hosp. No. 13277), white, American, male, aged thirty-nine years, was admitted to the hospital on August 24, 1921, complaining of pain in the left flank.

Family history: The patient was in the sixth generation of a known family of hemophilics (20). He had four brothers, three of whom were definite bleeders, and one brother died at the age of twenty-one years of an uncontrollable epistaxis. The patient was the uncle of E. H. T. (Case 4) and of G. L. (Case 5).

Past history: During the first thirteen years of life the patient was practically an invalid due to frequent hemorrhages from minor traumata. During this time his gums were spongy and bled almost constantly. This oozing was frequently interrupted by severe hemorrhages, due either to cutting teeth or to extractions. After puberty the bleeding from the gums stopped and the hemorrhage occurred only from cuts and other injuries. In 1911, following the extraction of a tooth, bleeding persisted for three weeks. Horse serum was given, but this had no effect. In 1914 the patient was in a railroad wreck and received a contusion of the left flank and fracture of the right tibia. In 1920 he had an attack of pain in the right lower quadrant which was followed by hematuria. Horse serum was given and was followed by polyarthritis, myalgia, and neuritis. The patient has had more or less constant pain in both knees and ankles for a number of years. These swell at frequent intervals and become quite stiff.

Present illness: The patient dated his present trouble to 1914, when he was struck in the flank, the pain having been present periodically ever since.

Physical examination: The general examination was essentially negative. The left foot revealed considerable pronation. Motion was practically normal in all directions. The right ankle showed marked limitation of lateral and antero-posterior motion. The left knee was swollen; the local temperature was not elevated. Extension was normal, but there was some limitation of flexion. Slight crepitus was felt. Considerable periarticular thickening was apparent.

Laboratory examination:

Urine	Negative for albumin and sugar
Red blood cells	3,880,000 per c.mm.
White blood cells	6,350 " "
Hemoglobin	56 per cent
Coagulation time	56 minutes
Prothrombin time	37 "
Platelet count	219,000 per c.mm.
Wassermann	Negative

Roentgen-ray findings: The left knee showed organization of an old blood clot, with thickening of the capsule of the joint. There were several areas of decreased density in the epiphyseal portion of the bone just beneath but not involving the articular surfaces, suggesting areas of bone destruction. The right knee showed evidence of effusion only.

The right ankle revealed absorption of the articular cartilage. There was marked eburnation of the lower end of the tibia and of the upper portion of the astragalus. There were a number of rounded areas of decreased density both in the tibia and astragalus, such as was seen around the knee. There was also evidence of an old

Fig. 3, Case 3. Old fracture. Destruction of articular cartilage, with areas of bone destruction in astragalus and tibia back of articular surfaces.

fracture of the lower end of the tibia, with some resultant deformity.

The elbows, shoulders, and hips were negative for any deformity.

Case 4. E. H. T. (Hosp. No. 15851), a white male, aged thirty years, was admitted to the hospital on December 22, 1921, complaining of bleeding from roof of mouth.

Family history (20): The patient was the nephew of R. T. R. (Case 3) and the cousin of G. L. (Case 5).

Past history: Throughout life the patient had suffered from hemorrhage or hematoma-formation after minor injuries. He had frequently been incapacitated by various joints becoming swollen and painful. In 1914 he twisted his left hip, and this was followed almost immediately by swelling, stiffness, and excruciating pain which incapacitated him for three months. The patient was always subject to epistaxis and when bleeding occurred it persisted for from one to six days. Four or five times each year various joints became tender and swollen without any preceding trauma. There was never a time when some joint did not feel lame.

Fig. 4, Case 4. Punched-out areas in external malleolus and indistinct areas in tibia and astragalus.

Present illness: This began eleven days previous to admission, with pain in the upper right jaw. Marked swelling and discoloration of the right side of the face developed and the right eye began to bulge forward. The swelling and discoloration spread down over the neck and chest. A hematoma formed in the roof of the mouth and ruptured three days previous to admission.

Physical examination: The skin and mucous membranes were very pale. The right side of the hard palate was the site of a large hematoma which was secondarily infected. From the center of this blood was slowly dropping. There was proptosis and discoloration of the right eye. Examination of the various joints was essentially negative.

Clinical course: The bleeding continued for five days and then stopped. He was later readmitted for hemorrhage following the extraction of an infected tooth. This persisted six days and was finally controlled by a transfusion.

Laboratory examination:

Red blood cells	3,408,000 per c.mm.
White blood cells	13,000 " "
Hemoglobin	60 per cent
Platelet count	192,000 per c.mm.
Coagulation time	73 minutes
Prothrombin time	95 "
Blood calcium	9.5 mgs. per 100 c.c. blood
P.M.N.	73 per cent
P.M.E.	3 " "
P.M.B.	0 " "
S.M.	11 " "
L.M.	13 " "
Trans.	0 " "
Blood Wassermann	Negative
Urine	Negative for albumin and sugar

Roentgen-ray examination: This included examination of both ankles. These both showed the typical punched-out areas of radiolucency in the epiphyseal portion of the bones, with intact articular surfaces. The right ankle showed these changes in the tibia, fibula, and astragalus, while in the left ankle these changes were seen only in the tibia. There was some thickening of the joint capsule, without any definite evidence of calcified blood clot.

Case 5. G. L. (Hosp. No. 68442), a white male, aged twenty-three years, was admitted to the hospital October 21, 1925, complaining of pain in both elbows.

Family history: Nephew of R. T. R. (Case 3) and cousin of E. H. T. (Case 4). The patient was in the seventh generation of a known hemophilic family (20).

Past history: During early childhood the patient had numerous severe hemorrhages after extraction of teeth. On one occasion the result was almost fatal. After puberty there was a decided lessening of the tendency to bleed. Pains in the joints have been bothersome all his life after any severe strain. At the age of twenty-one years, while playing hand ball the left hip became sore and rather stiff. During the next twelve hours the leg became fixed in flexion. There was tremendous muscle spasm and pain. There was complete disability for six weeks, and six months elapsed before recovery was complete.

Present illness: The left elbow first became swollen five years previously, following a strain. Since then the same course of events has recurred at gradually shortening intervals, and from traumata of slighter intensity. At the present time, simply driving an automobile for thirty miles is sufficient to cause tremendous swelling and severe pain. The symptoms persist for about three days and leave some residual soreness. For the past nine months the right elbow has begun to swell following any continued strain, such as driving an automobile. The swelling comes on gradually during the following twelve hours and when it is sufficient to cause complete immobilization then pain begins and persists for about twenty-four hours. There have been no symptoms in any other joints.

Physical examination: The general examination was negative. The right elbow revealed full range of motion. There was no swelling; the local temperature was not elevated; there was no pain on manipulation.

The left arm showed slight but definite atrophy of the musculature both above and below the elbow. There was no swelling around the joint. The skin was normal in appearance; the local temperature was not elevated. On gentle movement, both active and passive, there was no pain. There was definite limitation of both flexion and extension. Forced extension and flexion were painful.

Laboratory examination:

Red blood cells	4,160,000 per c.mm.
White blood cells	8,050 " "
Hemoglobin	93 per cent
P.M.N.	69 " "
P.M.E.	0 " "
P.M.B.	0 " "
S.M.	27 " "
L.M.	3 " "
T.	0 " "
Platelet count	280,000 per c.mm.
Coagulation time	57 minutes
Urine	Negative
Wassermann	Negative

Roentgen-ray examination: The left elbow showed an organized blood clot, with some calcification. There was thickening of the joint capsule and some absorption of the cartilage. The ulna revealed rounded areas of radiolucency to a marked extent, and the condyles of the humerus to a some-

Fig. 5, Case 5. Areas of bone destruction in ulna and humerus. Absorption of articular cartilage. Small calcified blood clot anterior to joint.

Fig. 6, Case 5. Normally appearing and functioning hips after a very severe hemarthrosis two years previously.

what lesser extent. The right elbow showed some thickening of the joint capsule. The shoulders, knees and hips were negative for pathology.

Case 6. C. J. (Hosp. No. 19223), a schoolboy, white, aged seventeen years, was admitted to the hospital March 26, 1923, complaining of bruises, sore joints and hemorrhage from the tongue.

Family history (20): Both the mother and father denied any tendency to bleed in either branch of the family.

Past history: At the age of five years the patient injured his right leg. This was followed by contracture of the knee, which was overcome by manipulation and application of a cast. Later a tenotomy on the Achilles tendon was done. There was severe hemorrhage and the period of convalescence was over two months in duration. Three years later the knee became swollen and the family was advised that he had tuberculosis of the joint. For a year previous to admission both elbows had become stiff, painful, and motion had become limited. An immoderate tendency to bleed had been observed throughout his life.

Present illness: While cleaning teeth with a tooth brush four days previously the frenum of the tongue was torn. Bleeding was profuse and a hematoma formed beneath the tongue, gradually increasing in size until the patient could not close his mouth.

Physical examination: The general examination showed a normally developed boy. The only points of interest were the mouth and the various joint deformities. There was a hematoma in the floor of the mouth pushing the tongue upward and holding the mouth open. There was a slight amount of oozing from one small area where the mucous membrane had ruptured.

The right foot revealed an equinus deformity. There was an extreme contracture of the Achilles tendon. The right knee showed a deformity suggesting a partial subluxation of the tibia. Flexion was readily performed to a right angle, but extension was interrupted at 170 degrees. There was some crepitus present on motion, and definite thickening of the periarticular structures.

The left elbow revealed slight limitation of flexion and about 25 degrees limitation of extension. There was slight periarticular thickening.

Roentgen-ray examination: The left elbow showed some absorption of the articular cartilage and some roughening of the bone beneath this. There were also several punched-out areas in the head of the radius. The right elbow showed some periostitis of the lower end of the humerus

extending to the condyles, and also of the neck of the radius. No other changes in the elbow were noted.

The right knee revealed absorption of the articular cartilage, with roughening of the bone beneath this. There was some thickening of the capsule of the joint. There was also a deformity of the upper end of the tibia suggesting an old epiphyseal displacement.

The right ankle showed a marked equinus, with some deformity of several of the tarsal bones but no definite joint destruction. There was marked osteoporosis.

Laboratory examination:

Red blood cells	5,170,000 per c.mm.
White blood cells.	9,600 " "
Hemoglobin	106 per cent
P.M.N.	76 " "
P.M.E.	1 " "
P.M.B.	0 " "
S.M.	14 " "
L.M.	6 " "
Trans.	3 " "
Coagulation time..	172 minutes
Prothrombin time.	163 "
Blood platelets ...	234,000 per c.mm.
Blood calcium....	9.6 mgs. per 100 c.c. blood
Blood Wassermann.	Negative
Urine examination.	Negative

Case 7. L. B. (Hosp. No. 42307), white, American, male, machinist, aged twenty-five years, entered the hospital April 7, 1924, complaining of pain and swelling of the right elbow.

Family history: The patient was one of three sons and was the only one to show a tendency to bleed. He did not know of any such hemorrhagic diathesis in any of his antecedents.

Past history: Between the ages of ten and twelve years the patient was completely incapacitated from hemorrhages while cutting his second teeth. At the age of twenty years, following a rather severe cut on his finger, oozing persisted for a month. A year later, he bled for a period of six weeks from a laceration of his upper lip.

Present illness: Spontaneous swelling and pain of the right elbow began seven years previous to admission. The patient did not remember any trauma. The pain and swelling would persist for a few days

Fig. 7, Case 7. Large calcified hematoma around the joint. Extensive cartilage and bone destruction.

and then subside, only to recur again periodically. At each recurrence the symptoms seemed more severe and the interval between attacks has gradually become shorter until at present the joint swells about every two weeks. The patient had never had joint symptoms except in the right elbow.

Physical examination: Examination was essentially negative except for the local condition. The right elbow showed considerable swelling. Flexion and extension were markedly limited. On motion, crepitus was readily felt. The skin was neither red nor discolored, and everywhere intact. The local temperature was not elevated.

Laboratory examination:

(4-10-24)

Red blood cells	4,240,000 per c.mm.
White blood cells.	9,600 " "
Hemoglobin.	89 per cent
P.M.N.	70 " "
P.M.E.	0 " "
P.M.B.	0 " "
S.M.	23 " "
L.M.	4 " "
Platelet count....	160,000 per c.mm.
Coagulation time..	36 minutes
Blood calcium....	7.7 mgs. per 100 c.c. blood
Urine examination.	Negative

There was no reaction following the injection of one milligram of old tuberculin.

Roentgen-ray examination: Films of the right elbow showed destruction of the articular cartilage, with extensive bone destruction of the articulating portions of

the humerus, ulna, and radius. The ulna showed the most marked involvement, with large areas of bone destruction extending into the body of the olecranon process and into the coronoid process. These changes were an extension of the process involving the articular surface. The humerus showed the typical punched-out areas, some of which were back of an intact articular surface. The radius showed an area of destruction in the outer side of the head. There was also the shadow of an extensive blood clot which had become organized with the deposition of calcium in it.

COMMENT

In Cases 3 to 7 the lesions seen were the result of repeated attacks of hemarthrosis and largely represent the late changes. The diagnosis in each case was verified by definite clinical findings and Cases 3, 4, and 5 were members of a known family of hemophilics (20).

In Case 3 the changes in the ankle were complicated by an old fracture, but, in addition, there was absorption of the articular cartilage and also the typical areas of bone destruction just beneath the articular surface.

The typical punched-out areas back of an intact articular surface were the most prominent changes seen in Case 4.

In Case 5 there is a history of a severe hemorrhage into the left hip two years previously, without any joint changes resulting although the severity was so great as to cause complete disability for six weeks. The left elbow presented the typical findings of an organized blood clot, capsular thickening, absorption of the cartilage, and areas of bone destruction.

Case 6 showed changes in both elbows, the right knee, and ankle. The findings in the left elbow were the most typical of these and presented alteration of both cartilage and bone.

The pathology in the knee and ankle is probably complicated by an old epiphyseal displacement of the upper epiphysis of the tibia with resultant structural and functional deformity.

In Case 7 the roentgen-ray findings were the most striking of those seen in any of the cases. The organized blood clot stands out with remarkable clarity. There is complete destruction of the articular cartilage and the bone destruction is extensive. The latter demonstrates the typical punched-out areas back of an intact articular surface in the humerus, as well as the destruction of the articular surface and underlying bone of the ulna.

From the brief review of the roentgen-ray findings, as noted in these seven cases, and in the review of the rather scanty literature on the subject, it would seem that two groups of roentgen-ray signs must be considered, *viz.*, (1) the signs seen in the early cases, or in those exhibiting no destructive change, (2) the signs seen in the advanced cases which exhibit destructive changes.

In the first group the findings include: (1) Effusion of blood into the joint; this may or may not show calcification. (2) Thickening of the joint capsule. (3) Lipping similar to hypertrophic arthritis. These changes may or may not be diagnostic, but the presence of a calcified hematoma in a case presenting joint symptoms is strongly suggestive of this condition. In these cases there is no bone destruction and no cartilaginous involvement. This type of case may suffer repeated attacks of hemarthrosis without the signs progressing beyond this point. Case 5 of this series has a normal appearing and functioning left hip joint two years after a well-substantiated attack of hemarthrosis of unusual severity. Cases of normal joints following a large number of attacks are also reported in the literature.

The findings in the second group are much more distinctive: (1) General or localized cartilaginous destruction. (2) Bone destruction of several varieties, (*a*) punched-out areas in the epiphysis, with an intact articular surface due to hemorrhage into the epiphysis; (*b*) destruction of the articular surface, often with localized

rounded areas of destruction extending into the epiphysis. (3) Blood clot in the synovial cavity which may become organized, with some calcification. The above signs are characteristic of hemophilic arthritis and when the typical punched-out areas of destruction are seen in conjunction with the organized blood clot the diagnosis can be made without other clinical data.

In differential diagnosis, tuberculosis is the principal joint lesion to be considered. The main differences between this and tuberculosis are the clearness of outline of the articular surfaces, the peculiar type of punched-out areas already described, and fluid in the joint, which is likely to undergo organization with deposition of calcium.

SUMMARY

In this communication only a few of the well-known facts of hemophilia in general are presented, as these are adequately covered elsewhere. We have briefly covered some of the available literature on hemophilic arthritis, with reference to the roentgen-ray changes, and have given case reports of seven of these patients, with a brief statement concerning the roentgen-ray observations taken from the study of these cases in conjunction with the findings reported in the literature. Two of these cases are classed as early in that no bone destruction was noted. Most of these observations noted in the early cases concern the soft tissues, with the exception of the lipping which is seen after repeated attacks. Five of these cases might be classed as advanced cases in that the lesion has progressed to the destructive stage. The distinguishing changes in these lesions are: (1) cartilaginous destruction; (2) punched-out areas of bone destruction in the epiphysis; (3) organized blood clot in the synovial cavity.

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DISCUSSION

Dr. C. G. Sutherland (Rochester, Minn.): Cases such as Dr. Doub has presented are very puzzling from the standpoint of general diagnosis, and he is to be congratulated on his manner of bringing them before the Society. It is the elucidation of our everyday problems in diagnosis that makes these meetings so well worth attending.

FRACTURES OF THE OS CALCIS: DIAGNOSIS AND TREATMENT[1]

By H. R. CONN, M.D., Akron, Ohio

THE calcaneum, or os calcis, enjoys the distinction of being more frequently fractured than any of the other tarsal bones, and even comparatively the lesion is not rare. Strauss states that it comprises 2 per cent of all fractures, while Cahill, in an analysis of seventy-two cases ranging in age from fourteen to seventy-three years, places the percentage at between two and four. It is commonly the result of direct violence induced by a fall in which the victim alights upon the feet. The superimposed body weight exerts a crushing force producing impactions occasionally, but more frequently explosive comminution. Rarely a separation of the attachment of the tendon Achilles results from muscular activity.

Invariably the treatment presents difficulties which must be intelligently surmounted unless more or less incapacitating and permanent deformities are to result. Structurally, the os calcis, by reason of the absence of a shaft and because of its spheroidal shape, offers very evident restrictions to manipulation and immobilization. The anatomical relations are complex and any distortion is magnified in gravity by the importance of the reciprocal articulations. Further, the ligamentous attachments are of negative value as fulcrums against which reduction may be facilitated or maintained, and in particular the most important attachment, that of the tendon Achilles, is generally a malevolent influence toward the exaggeration of the deformity.

Magnuson quotes Cotton as stating that 90 per cent of the cases present a permanent partial disability, while he himself, writing from an extensive experience with the Illinois Industrial Board, asserts that all cases show an ultimate loss of function ranging from 35 to 75 per cent. Cotton and Henderson, in an analysis of seventy-five cases, published in 1916, conclude their report in this significant manner: "Conservative treatment gives incredibly bad results. We must do better than this; it must be possible."

PREVIOUS CLASSIFICATIONS

Miscellaneous attempts have been made, notably by Cabot and Binnie, to classify the various types of fracture peculiar to the calcaneum. They divide the calcis by an imaginary vertical plane passing through the center of the astragalus and find the posterior portion to be subject to the following lesions: cases with one large heel fragment, cases with one small heel fragment (avulsion fracture), and cases with cracks and fissures without separation. That portion of the calcis lying anterior to the vertical plane comprises an individual second group and, lastly, Cabot and Binnie refer to severe crushing fractures of the whole bone. Lounsbury divides his cases into: fractures through the concave facet beneath the convex facet of the astragalus, vertical fractures from just in front of the tuberosity running beneath to a point just behind the posterior border of the convex articulation with displacement upward of the posterior fragment, tear fractures usually of the tuberosity, combinations of two or more of these types, and, lastly, compound fractures. Cahill finds these delineations unsatisfactory and suggests a more classical grouping, which is omitted.

The assorting of these various traumatic lesions into the impacted, linear, comminuted, and compound types is purely of academic interest. The type of fracture is of importance only as it relates to the immediate treatment and to the ultimate disability which it may produce. A grouping based upon the characteristic deformities resulting from fracture and discussed as to the surgical significance should be mutually helpful to roentgenologist and surgeon alike.

[1] Read before the Radiological Society of North America, at Cleveland, Ohio, December, 1925.

SUGGESTED CLASSIFICATION

Excepting, perhaps, the astragalus, which is much less susceptible to violence, the os calcis is the most important component of the weight-bearing mechanism of the foot. The anatomical relation is such that the body weight falls mesial to a perpendicular line drawn through the center of the posterior tuberosity: this line more nearly traverses the junction of the sustentaculum tali with the body (Fig. 1). Any distortion of the bone, such as an impaction, which causes further mesial deflection of the weight-bearing line, will assuredly induce pain and discomfort by reason of the ligamentous strain. Clinically the resultant deformity is a spastic eversion of the foot with prominence of the internal malleolus, spasm of the peroneal muscles and a valgoid gait. Pain is evident on the bare attempt to support the body's dead weight upon the heel.

The os calcis attains additional physiological importance by virtue of its function as the posterior pillar of the longitudinal arch of the foot. It is, therefore, a major component of the spring mechanism and directly concerned not only with weight-bearing but with normal painless locomotion. Unfortunately the greater number of fractures involving the calcaneum traverse the posterior tuberosity and, unless impacted, the dorsal fragment is invariably carried upward by the tendon Achilles (Fig. 2). The arch is thus flattened, the calcaneo scaphoid ligament stretched or torn, and the relations of the normal articulations disturbed. Clinically, such a foot presents a marked planus of the longitudinal arch, tenderness to pressure under the calcaneo scaphoid ligament, eversion of the foot, and spasm of the peroneal tendons. There will be moderate pain in the attempt to support the resting weight of the body on the heel, but locomotion requiring physiological activity of the long plantar arch will prove exquisitely painful, or impossible.

Frequently the fracture is of the impacted type, in which case the tendon Achilles exerts little or no deforming influence. The impaction as a rule spends its force upon the posterior tuberosity, with the production

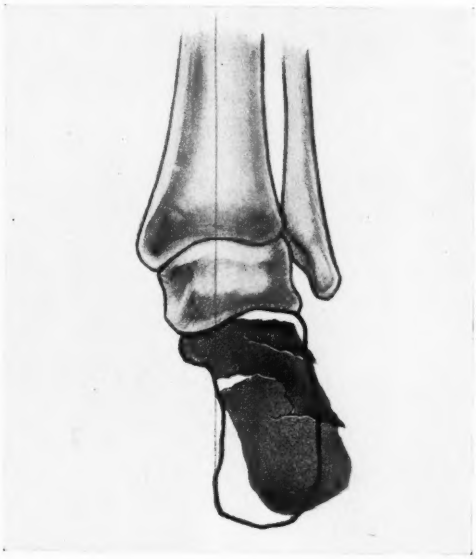

Fig. 1. Diagrammatic anteroposterior view through the right heel, illustrating a type of impaction productive of eversion of the calcaneum with a more mesial deflection of the weight-bearing line.

of a somewhat characteristic deformity. The dorsal pillar is shortened, thickened, and displaced upward, while the dislodged but undetached bone mass is driven upward to the outer surface of the calcaneum, to impinge against the external malleolus (Fig. 3). Clinically, the foot presents evidences of shortening and thickening of the heel and there are present in varying degrees the symptoms of traumatic flat foot. More commonly there is pain at the point of attrition between the outer surface of the os calcis and the malleolus and a distinct loss of lateral motion which renders walking over uneven surfaces difficult and painful.

Fractures which involve the articulations deserve especial mention. The sub-astragaloid joint is frequently invaded by fracture lines and its surface distorted (Fig. 4).

Adhesions and a persistent arthritis are the usual sequelæ. Complete ankylosis, unfortunately for the patient, occurs infrequently. Walking is distinctly inhibited by the limitation of lateral motion and rendered acutely painful by the attempt to negotiate any uneven plane.

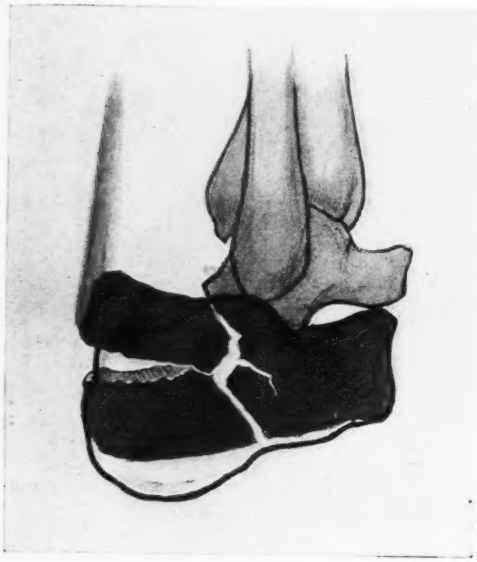

Fig. 2. Diagrammatic lateral sketch of right foot, illustrating upward displacement of the distal fragment of the posterior tuberosity of the os calcis.

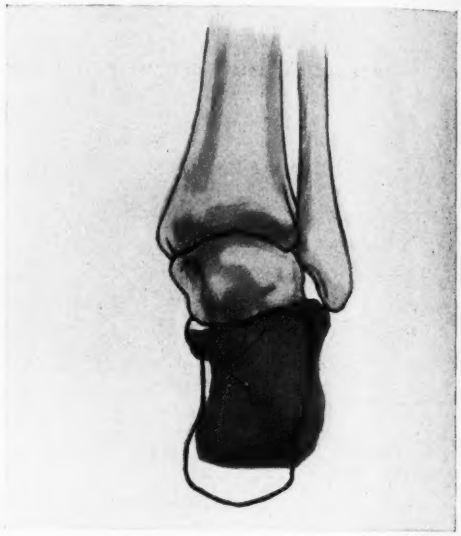

Fig. 3. Diagrammatic anteroposterior view of the right heel, illustrating a type of impaction productive of shortening and thickening, with impingement of the displaced bone mass against the external malleolus.

Less frequently non-union occurs in fractures of the os calcis. Statistics are not available, but in the writer's experience non-union has persisted in a majority of these cases in which the original fracture traversed that portion of the bone anterior to the sustentaculum tali (Fig. 5). Apparently it less frequently follows fractures of the posterior tuberosity and need hardly discourage such operative procedures as manipulation and osteotomy. When present, non-union induces serious and prolonged incapacitation.

Summarizing the above groups, it will be noted that fractures of the calcaneum divide themselves on a basis of the predominating deformities into: (1) an eversion of the bone with a more mesial deflection of the weight-bearing line; (2) upward displacement of that portion of the posterior tuberosity serving as the attachment for the tendon Achilles; (3) impactions resulting in shortening and upward displacement of the posterior tuberosity, without separation of the tendon Achilles; (4) serious distortion of the reciprocal articulating surfaces, and (5) those cases in which by reason of the location or because of destructive comminution non-union is impending or present.

These groups represent only the major findings, important from a surgical viewpoint. Two or more of the predominating lesions may be, and frequently are, present in a single case.

ROENTGENOGRAPHY

It is not imperative that the roentgenologist accede to this suggested grouping. It is, however, tragically important to the patient that he recognize the major deformity which presents itself and acquaint the surgeon with its presence and significance. The radiographer assumes invariably the

rôle of the first and often the sole consultant, a fact which charges him with a double responsibility. The mere discovery of a solution in the continuity of the calcaneum in no manner discharges the obligation, nor

Fig. 4. The right os calcis viewed from in front, showing multiple fracture lines traversing the sustentaculum tali and the major calcaneo-astragaloid articulation.

is much added to the value of the radiographic report by the addition of such meaningless words as linear, stellate, comminuted, etc. The surgeon is entitled to a stereoscopic lateral view of the suspected os calcis and a view taken through the posterior tuberosity in the antero-posterior plane. It is the writer's custom to request similar exposures of the unsuspected side, first, as a precaution against overlooking a bilateral lesion and, second, as a basis for the estimation of the degree of the deformity. The ancient cases in which early treatment has terminated unhappily demand equally as careful radiography and perhaps even a better appreciation of the significance of the major deformities. The attending surgeon, often inexperienced in bone work, is here particularly entitled to the benefit of the roentgenologist's greater familiarity with the normal configuration and relationship of the tarsal bones.

TREATMENT

Attempts at manual reduction followed by immobilization have characterized the preliminary efforts of all the early writers and account for most of the unhappy end-results. Cotton and Henderson, in 1916, suggested a procedure particularly applicable to the cases of upward displacement of the posterior tuberosity, namely, the insertion of a steel sound through small lateral skin incisions just above and anterior to the insertion of the tendon Achilles. Under anesthesia, with the knee flexed and the sound used for traction the posterior fragment was pulled forcibly downward, while counter pressure was made under the arch, and reduction accomplished. In 1921, Cotton further suggested that, once reduced, immobilization might be secured by impacting the fragments. A felt pad being used on either side of the foot to protect the malleoli, the outer side was held firmly against a rigid table and the inner side struck sharply two or three times with a mallet. At a later date, Cotton suggested that impactions in positions of deformity might also be broken up by the similar use of a mallet. Foldes has suggested the use of Fischer's traction apparatus to counteract the upward pull of the gastrocnemius soleus group. Strauss accomplished reduction by using a Steinman pin above the posterior tuberosity, combined with traction upon a Hawley table, immobilization being maintained by a plaster cast. In the comminuted and impacted cases Becker made an incision underneath the calcaneum; an elevator was passed through the foot and the arch restored by forcible leverage upward. Fixation was secured by inserting a drill subcutaneously through the long axis of the posterior tuberosity and breaking it off *in situ*. Tenotomy of the heel cord has been included as part of the procedure of some writers and opposed as unnecessary by others. Fixation of a displaced dorsal fragment has been accomplished by the use of nails, wire, and kangaroo tendon. For the disabilities arising from the ancient lesions, a bewildering variety of procedures, including wrenching, tenotomy, osteotomy, and arthrodesis have been suggested.

It may be observed that most of the operative procedures above mentioned have chiefly concerned the reduction of a single deformity, namely, upward displacement of all or a portion of the posterior tuberosity.

Fig. 5. The right os calcis viewed from the outer side, showing extensive comminution of that portion of the bone anterior to the sustentaculum.

Unfortunately, fractures of the calcaneum do not invariably present this lesion as the major deformity, a fact which renders any attempt at therapeutic standardization impossible. Intelligent treatment requires that each case be met as an individual problem and that the method or methods necessary to secure anatomical restoration be boldly instigated.

Considering, first, the group in which the deformity is primarily a more mesial deflection of the weight-bearing line, the indication is clearly not for forcible traction downward upon the heel bone. Furthermore, a degree of impaction is generally present, sufficient to render any attempt at manual reduction ineffectual. The logical procedure is a thorough breaking up of all impaction under a general anesthetic by means of a Thomas wrench, the blades of which are applied to the lateral sides of the tuberosity and the force exerted toward the correction of the eversion. Any tendency toward upward displacement should be blocked by a tenotomy of the heel cord and the foot immobilized in plaster at right-angle flexion, with inversion. Massage should precede weight-bearing and the arch be further protected by a metal plate or Thomas heel. Failing to accomplish reduction, the writer strongly favors an arthrodesis of the sub-astragaloid joint, so reshaping the opposing surfaces of the os calcis and astragalus as to secure normal alignment of the weight-bearing line. This operative procedure is easily applicable to both new and ancient cases and is infinitely more rational than an osteotomy through the tuberosity.

The second group, or those cases in which there is upward displacement of that portion of the tuberosity serving as the attachment of the tendon Achilles, respond well to a preliminary tenotomy, followed by the reduction method of Cotton and Henderson. The attempts at maintenance of the reduction by impaction of the fragments with a mallet have not been more satisfactory than the less violent and more certain operation of tenotomy. If the heel cord is left undivided and the fragments unimpacted, some degree of displacement is certain to occur and can be positively prevented only by the use of internal fixation. Open operation and the application of wire, metal plates, nails, or kangaroo tendon entails considerably greater risk and is not more effectual than the simple and under-valued operation of tenotomy. The so-called avulsion fracture, of rare occurrence, in which only a small bone fragment is torn loose with the tendon Achilles and displaced upward, is a possible exception. Here tenotomy need not be done and most excellent results follow fixation with a nail. Through a small nick in the skin, which has been pulled upward, the nail may be inserted into the displaced fragment, traction downward upon the nail made to accomplish reduction, and final fixation completed by driving the nail on into the posterior tuberosity. Penetration of the calcaneo-astragaloid should be carefully avoided. Union is generally firm enough to permit removal of the nail during the fourth week.

Those cases with firm impaction in which the posterior tuberosity is shortened and thickened and a mass of undetached bone driven upward under the external malleolus, are always most difficult. Manual reduction is hopeless and the usual traction methods disappointing. Infrequently a degree of re-apposition can be obtained by means of the Thomas wrench, but unfortunately the displaced lateral bone mass is inaccessible and remains the most disabling feature of these lesions. The method of Becker may offer a solution, but comment is withheld because of a lack of personal experience. The same applies to osteotomy of the posterior tuberosity for the correction of the upward and external displacement. Magnuson has described an operation practised upon the ancient cases which is equally as applicable to the recent ones. Briefly, a generous lateral incision is made, partly encircling the external malleolus. The embedded or adherent peroneal tendons are freed and a new bed formed for them by chiseling away the untoward bone and fashioning a new groove into the lateral surface of the calcaneum. The open operation is followed by wrenching to force the foot into inversion, in which position it is dressed. In the recent case, the procedure is best reversed. As soon after fracture as the tissues will permit of further traumatization the foot is wrenched into full inversion and so immobilized until all swelling and ecchymosis have disappeared. Magnuson's operation is then done, particular care being taken to remove sufficient bone from the lateral surface of the os calcis as to preclude any possibility of future impingement against the external malleolus. Massage and passive motion should be instituted at an early date in order to prohibit the possibility of adhesions about the peroneal tendons. The plantar arch requires support for an indefinite period, preferably with a plate of the Whitman type.

Fractures which involve chiefly the articulating surfaces give rise to a persistent arthritis, peculiarly productive of pain and disability. The calcaneo-cuboid articulation is of negative importance in this respect, but the sustentaculum tali and the major calcaneo-astragaloid facets cannot be so dismissed. The disabilities arising therefrom are prolonged and incapacitating and tend to increase in severity. Applied to the ancient cases, physiotherapy, metal arch supports, and wrenching have been of no avail. The writer strongly favors a sub-astragaloid arthrodesis, accomplished through a wide exposure of the joint, permitting of anatomical re-apposition of the calcaneum and astragalus following the denudation of the articular surfaces. If the eversion is marked the peroneal tendons should be lengthened and the foot dressed in slight inversion. Consolidation is complete in four to six weeks. Wilson[2] has applied sub-astragaloid arthrodesis to a series of fresh cases with excellent results, while the writer's experience has extended only to the ancient lesions. The value of the operation in both the recent and the old cases has not been fully appreciated and deserves a more general acceptance.

The last type of lesion, in which non-union persists, is possibly the most trying of all. Non-union has never been observed in fractures of the posterior tuberosity, but is not infrequent following fractures of that portion of the bone lying anterior to the sustentaculum. Attempts to secure fusion by impaction have been signal failures, while the use of grafts is impractical and has not been attempted because of the surgical inaccessibility of the calcaneum. Small chip fractures in proximity to the calcaneo-cuboid joint are best treated by removing the small fragments and arthrodesing the joint. Those traversing the constricted portion of the bone just back of the calcaneo-cuboid joint constitute a more serious problem and require an extensive open operation. The writer—in the only case of this kind upon which he has been permitted to operate—secured an excellent result by a method similar to that employed by Hoke upon the astragalus in stabilizing

[2] WILSON, P. D.: Personal communication, Oct. 25, 1925.

operations. The external surface of the calcaneum was exposed by a lateral incision beginning over the calcaneo-cuboid articulation and extending backward to expose the sub-astragaloid joint. The capsule of the calcaneo-cuboid articulation was incised and the distal fragment of the os calcis mobilized and removed. An arthrodesis of the sub-astragaloid joint was next accomplished and the articular cartilage curetted from the cuboid. The detached fragment was also denuded of joint cartilage, the fracture line freshened and the piece replaced *in situ*. Union was firm in four weeks.

COMMENT

The most casual experience with fractures of the calcaneum cannot fail to verify the contemporary observation that the end-results continue to be "incredibly bad." Non-union, persistent arthritis, loss of lateral ankle motion and architectural distortions of the weight-bearing mechanism are grievous reflections upon the present treatment. Even worse, however, are the functional limitations which they ultimately induce. The ancient lesions invariably exhibit a traumatic planus of the long arch, associated with prominence of the internal malleolus, abduction of the forefoot, eversion of the whole foot, and a marked peroneal spasm. The painful valgoid gait is almost pathognomonic and mirrors the underlying deflection of the line of weight-bearing. Curiously, the literature ignores the most disabling feature of these fractures, namely, the lateral deflections, and concerns itself largely with the more evident and easily remedied displacements upward.

The reduction methods now in vogue are not inadequate as applied to upward displacement; they are only valuable for the correction of the concomitant lateral deflections of such sad consequences. These lateral deviations are difficult, but not impossible, to recognize in the roentgenograms, and should be carefully sought. The indications for treatment are entirely dependent upon the existing deformity, and we wish to reiterate the responsibility which attaches to the roentgenologist.

The calcaneum presents upon its superior surface a broad facet which faces upward and forward to articulate with the astragalus. This articulation is readily accessible surgically and is situated in such a plane that an excision of the joint can be made to correct any upward, downward, or lateral displacement. At the same time, the arthrodesis effectively eliminates those symptoms arising from a persistent arthritis, and, secondarily, relieves the peroneal spasm. Further, arthrodesis is valuable in certain cases of non-union. The operation is without appreciable risk, the loss of lateral motion which results is not disabling, and recovery is complete in six to eight weeks. Sub-astragaloid arthrodesis does not enjoy the appreciation which its effectiveness warrants.

CONCLUSIONS

1. Fractures of the os calcis are serious and disabling injuries in which the end-results continue to be "incredibly bad."

2. The lesions divide themselves on a basis of the predominating deformity into five major groups, with specific indications for surgical treatment.

3. The indications for treatment are entirely dependent upon the recognition of the predominating deformity or combination of deformities, a fact which charges the roentgenologist with a considerable responsibility.

4. Roentgenograms should be taken in a manner well calculated to reveal both the lateral and the perpendicular deviations which may occur.

5. In the recent lesions, procrastination, attempts at manual reduction, and ineffectual immobilization should be abandoned for the more radical and efficient direct traction procedures, tenotomy of the heel cord and, when indicated, sub-astragaloid arthrodesis.

6. Applied to both the recent and the ancient cases, sub-astragaloid arthrodesis

deserves a much more general acceptance than it is now accorded.

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Bladder reflux.—By "bladder reflux" is to be understood the regurgitation (backflow) of bladder contents into the ureters and renal pelves. The condition may be congenital or develop in post-natal life. That it is not a permanent affection is shown by the first case reported, in which a marked reflux complicating atony of the bladder and due to spinal syphilis entirely disappeared after appropriate local and general treatment.

Reflux plays an important part in carrying the infection from the lower to the upper urinary tract and explains the recurrence and resistance to treatment in such cases.

It may lead to an erroneous diagnosis of bilateral renal tuberculosis because it is a frequent complication of that disease.

It is extremely rare in normal persons and during pregnancy. Acute and chronic cystitis favor it because of changes in the lower ureter preventing proper closure of the orifice on one or both sides.

In ninety-one cases, including normal persons, pregnancies and various vesical and renal conditions, reflux was found in only five, or 5.4 per cent, most frequently in infections of the bladder and kidney, both tuberculous and nontuberculous. Obstruction at the vesical neck is a comparatively rare cause of reflux.

There is still much difference of opinion as to the reason why the mechanism at the ureterovesical junction, which normally opposes the reflux of bladder contents, should fail to function. Some hold that a hypertonic vesical musculature forces the ureteral orifices open. Some believe that a congenital insufficiency will explain all cases. A third group holds that changes in the wall of the lowermost portion of the ureter from lack of innervation or disease prevent the proper closure of the orifices. One must concede that all three of these may co-exist, or even, acting alone, be sufficient cause for the phenomenon.

W. W. WASSON, M.D.

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STUDIES OF THE ROENTGEN ERYTHEMA OF THE HUMAN SKIN

I. SKIN CAPILLARY CHANGES AFTER EXPOSURE TO UNFILTERED RADIATION [1]

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THE observation of a considerable number of cases showing late reactions after X-ray radiation received from a few months to several years ago, has induced us to undertake a study of the roentgen erythema of the human skin.

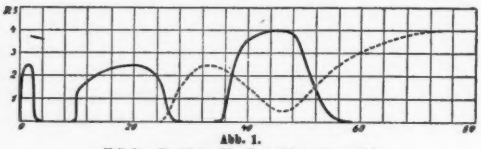

Fig. 1. The straight line represents the degree of erythema, the dotted line the pigmentation. (Taken from G. Miescher, Strahlentherapie, 1924, Vol. 16, p. 340.)

Our present dosage system in X-ray therapy is a method which might be called the physico-biological method, because it consists of a (biological) dose transferred to some measuring instrument with which we may calibrate other tubes and other apparatus. The unit of X-ray treatment is called skin unit dose (S.U.D.), or, sometimes, erythema dose (E.D.), corresponding to the H.E.D. in German literature. This skin unit dose has been criticized recently (1) because it is subjected to many individual or personal errors; what one may pronounce to be a full erythema dose is probably 80 per cent or less[2] of the dose some other observer is using, even if the threshold value of the erythema is considered, *i.e.*, the minimum amount of X-ray radiation that will just cause a slight reddening of the skin from eight to ten days after the exposure. This personal error can not be ruled out. Our problem, therefore, comes to this: after we have developed a measuring device enabling us to measure a certain amount of X-rays as physically exact as possible, we must try to establish a reliable biological unit which every physician can judge within a reasonable limit of allowed error. As far as the physical side of the problem is concerned, we might mention that the German Bureau of Standards has adopted a unit for calibrating the output of X-ray tubes; the unit is called one Roentgen (Kuestner, 2), (Behnken, 3), (Grebe and Martius, 4). But this still leaves the other part of the

Fig. 2. The skin microscope. (O. Mueller.)

[1] Read before the Radiological Society of North America, at Cleveland, Ohio, December, 1925.

[2] Martius (Strahlentherapie, 1924, Vol. 18, p. 395) has published the results of measurements on twenty-seven X-ray machines in fourteen clinics, and, if taking his own erythema dose as 100 per cent, a difference from 66 per cent to 258 per cent in the H.E.D. of the other investigators was noted.

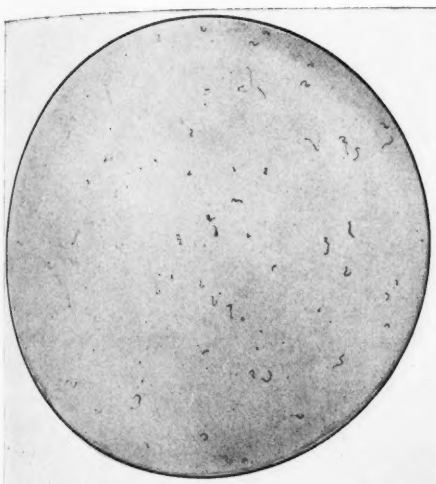

Fig. 3. Normal skin capillaries.

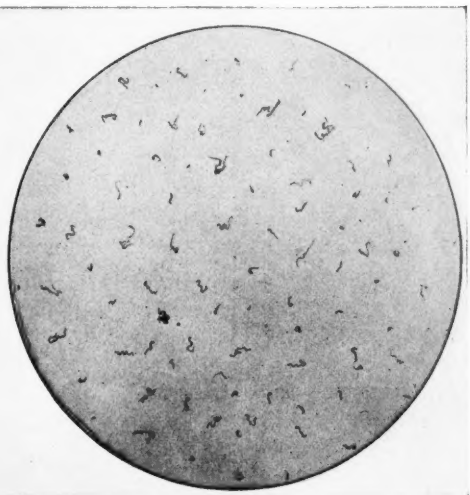

Fig. 4. Six hours after the exposure.

problem unsolved: the establishing of a well defined biological unit. In that connection, we would like to say that little has been done in the study of the roentgen erythema of the human skin. Outside of the older publications (5), there is only the well known definition of Seitz and Wintz (6), which is still in use. Recently Miescher (7) has made a detailed study of the roentgen erythema and comes to the conclusion that there is not only one or two erythemas, showing sometimes as so-called early reaction shortly after the treatment and as a rule seven to ten days later, but the reaction appears in three or four cycles (Fig. 1) following each other at intervals from one to several weeks. The dose producing such reaction may be in the ratio of one to seven.

As long as we are working with a radiation of relatively long wave length (superficial therapy), the variation in the observation of the erythema is not so material for a single unrepeated exposure; but if it comes to a series of treatments or a filtered radiation of short wave length (deep therapy), the fluctuation of the erythema dose as given by different observers will be very important; the effect on the depth dose, for instance, is obvious.

Since the publication of Ricker (8) as to the effect of radiation on capillaries, the opinion that the smaller blood vessels are a *locus minoris resistentiæ* for the roentgen rays, has gained more and more recognition. Supported by histological findings,[3] it seems rather probable that many a phenomenon,—although not all,—observed in the course of X-ray treatments, *e.g.*, the visible erythema on the skin, may be explained by some disturbance of the normal functioning of the capillaries.[4]

We must, therefore, regard the investigations of O. Mueller (9) and his co-workers (10, 11, 12), who studied the capillaries of the living human skin under normal and abnormal conditions and after X-ray exposure, as a valuable step toward the improvement of our biological dosage problem.

This observation of the skin capillaries in the living human being was first reported by C. Hueter (13), while the first systematic work was done by W. P. Lombard (14). David and Gabriel (15, 16, 17) have published the results of their extensive

[3] See Wetterer, *loc. cit.*, p. 336.

[4] Fahr (Virch. Arch., 1925, Vol. 254, p. 277) believes that the direct injury of the cells is the dominating cause for X-ray reactions of second and third degree.

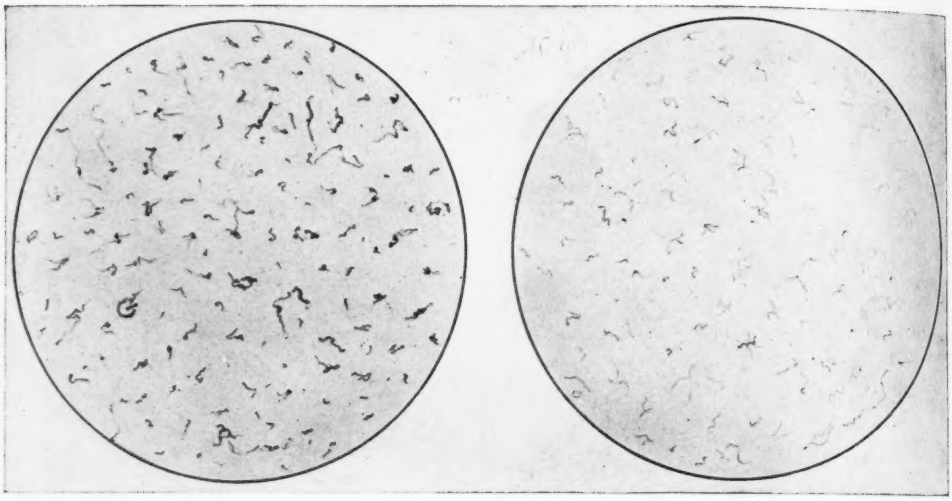

Fig. 5. Twenty-four hours after the exposure.

Fig. 6. Forty-eight hours after the exposure.

studies of the skin capillaries after X-ray treatments, and they conclude that it is not only evident that the capillaries show distinct changes almost parallel to the visible reaction on the skin, but that it is also possible to get an idea of the susceptibility of a person to X-rays by studying the capillaries before the treatment.[5] They also showed that the capillary changes in the deeper tissues are the same as in the skin.

Inasmuch as all the capillary studies published so far have been made on patients, and in view of the interesting findings of Miescher,[6] we decided to expose the skin of normal individuals to roentgen rays and follow up the visible reaction in comparison with the capillary changes.

METHOD

In describing the method we quote Krogh (18): "The method consists simply in placing a drop of highly refractive transparent oil on the skin. The oil will produce a smooth surface, and, by replacing the air in the surface layers of the epidermis, make this so far transparent that the papillæ of the cutis and their capillary loops may become visible when illuminated by an oblique beam of strong light. The application of a cover slip (Schur, 1920) may sometimes prove advantageous. In most fields it is possible only to see the tips of the capillary loops, but at the base of the finger nails the papillæ are seen in profile, and a number of loops can be observed in their whole length."

The device we have employed is the capillary microscope (Fig. 2) designed by Mueller, with which it is very simple to work. Its magnifying power is 60 ×.

It may be stated here that, in our opinion, there is considerable variation in the skin capillaries of normal individuals (Callander, 19), and it seems advisable to take certain precautions before drawing any conclusions from the observations made. We have used, in the experiments reported here, normal persons (eight males and four females), and we have always examined symmetrical parts of the body. We could convince ourselves that no marked difference was to be noted between symmetrical spots in one person, but, in order to be sure, we have examined that part of the skin we intended to irradiate over a period of several days in order to get, if we may say so,

[5] This was contradicted by Schugt (Muenchen. med. Wchnschr., 1922, p. 1178).

[6] Miescher, *loc. cit.*

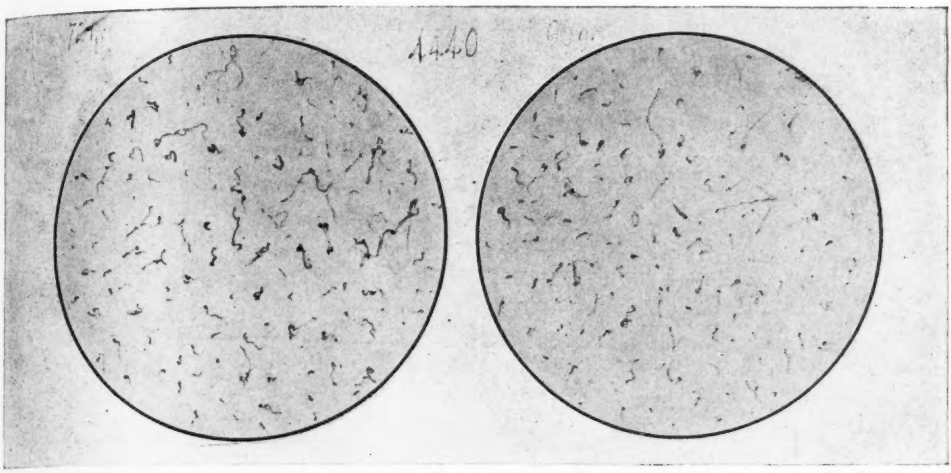

Fig. 7. Seventy-two hours after the exposure.

Fig. 8. Ninety-six hours after the exposure.

a mean value of the normal capillary appearance. That the skin must be perfectly clean; that only pure cedar oil be used, and that no pressure shall be exerted on the part examined, are understood. We chose the upper flexor side of the forearm, where a round area of about 2 cm. diameter was exposed. In marking the degree of erythema and pigmentation, we followed Miescher[7]:

Erythema
- (1) Just visible reddening.
- (2) Definite erythema.
- (3) Dark red.

Pigmentation
- (1) Faint tanning.
- (2) Definite tanning.
- (3) Dark brown.

We agree with Callander[8] that it is very desirable to photograph the capillaries, but, on the other hand, if there is an experienced artist available to make the drawings, this method may be accepted.[9]

The radiation used is characterized as follows: 9-in. spark gap, no filter, 5 ma., 30 cm. F.S.D., ½ and 1 total skin unit (1 resp. 2 minutes). We have studied the capillaries six, twenty-four, forty-eight, and seventy-two hours after the exposures, and so on, daily, until the erythema disappeared, then once a week over a period of from four weeks to three months. No filtered or deep therapy radiation was used; we did not feel justified in exposing persons to this agent for experimental purposes.

[7] Miescher, G., *loc. cit.*

[8] Callander, *loc. cit.*

[9] The author is indebted to the medical illustrator of the University Hospital, Miss E. S. Perry, who has prepared the illustrations for this paper.

EXPERIMENTAL

1. Exposure with 100 per cent S.U.D.

The six cases of this group showed more or less the same reaction; it may truly be said that reproducing one of the series will give a sufficient general idea of the observed capillary changes. The normal appearance of the capillaries is illustrated in Figure 3. The background is rather pale, only the superficial vessels being visible. An attempt is made to describe the changes taking place after X-ray exposure, but one must realize that only actual study of the skin will give a correct impression. There are changes continually taking place, due to the normal functioning of the blood vessels synchronous to the heart action. It is very difficult, therefore, to draw an absolutely true instantaneous picture.

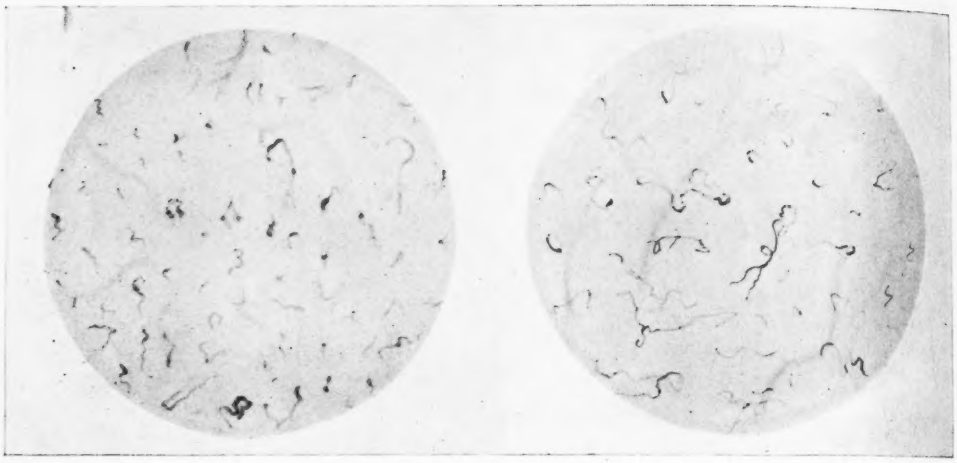

Fig. 9. Seven days after the exposure.

Fig. 10. Nine days after the exposure.

July 27, 1925; 100 per cent S.U.D., unfiltered, on the right or left forearm, flexor side.

After 6 hours: Slight reddening of the treated area; capillaries increased in number; the "reserve capillaries," *i.e.*, vessels which do not show under normal conditions, are filled; the deeper layers (subpapillary vessels) are not visible (Fig. 4).

After 24 hours: Reddening more pronounced; capillary loops thickened (Fig. 5).

After 48 hours: The erythema has decreased; the capillaries are less filled; the picture presents a return to normal conditions (Fig. 6).

After 72 hours: No marked changes (Fig. 7).

After 96 hours: The same, erythema fading (Fig. 8).

After 7 days: No change occurred until the sixth day; the erythema, which had practically disappeared, came on again, the capillaries were increased in number, dilated and showed a considerable number of the deeper layers on a purple background. The reserve capillaries are filled, and the loops, *e.g.*, the connection between arterial and venous arm, are thickened; no interruption in the blood stream. This "second erythema" is the usual erythema referred to in the definition for the S.U.D., appearing after 7 to 10 days (Fig. 9).

After 9 days: The eighth day showed nearly the same as in Figure 9, only to a slightly lesser degree; on the ninth day the decreasing tendency was already very pronounced (Fig. 10).

After 3 weeks: The interval was characterized by a slowly decreasing reaction. On the seventeenth day there was a suggestion of pigmentation; the background in the microscope had a yellow tint. On the twentieth day a very definite reddening of the skin could be noticed. The capillary picture corresponded very nicely to this macroscopic observation (Fig. 11).

After 1 month: During the fourth week the erythema faded and a definite pigmentation took place. The capillaries showed a slow return to normal conditions (Fig. 12).

After 6 weeks: Very characteristic picture of the period of recovery; superficial capillaries are visible only, elongated to some extent; marked pigmentation of the skin (Fig. 13).

After 2 months: The capillaries are practically normal in size, shape and num-

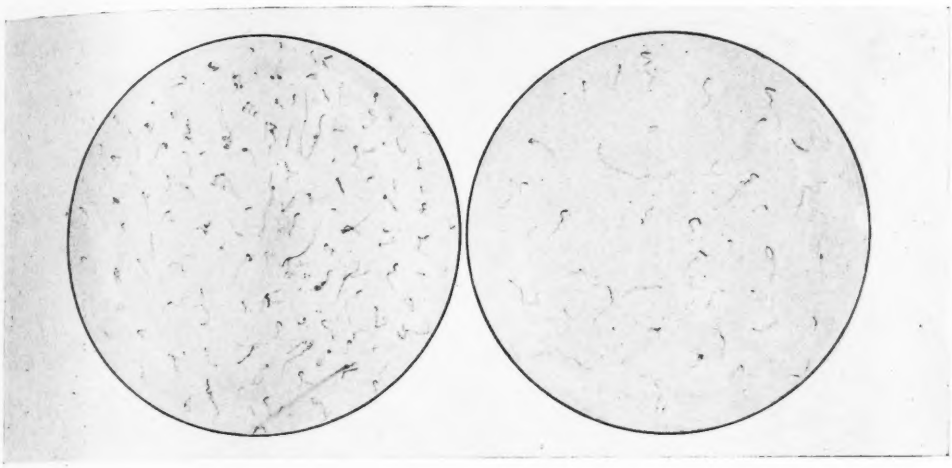

Fig. 11. Three weeks after the exposure.

Fig. 12. One month after the exposure.

ber; a very slight tanning is still macroscopically recognizable.

After 10 weeks: Normal capillary appearance; pigmentation fading.

TABLE I

Time record of erythema and pigmentation after 100 per cent S.U.D.

Time	Erythema	Pigmentation
0 hours	–	–
6 hours	1	–
24 hours	>1	–
2 days	>1	–
3 days	–	–
4 days	–	–
7 days	3	–
9 days	2	–
3 weeks	1–2	>1
4 weeks	–	2
6 weeks	–	>2
8 weeks	–	1
10 weeks	–	>1
3 months	–	?

After 3 months: In none of our six cases could the treated area be recognized distinctly;[10] there were no capillary changes present. A complete return to normal conditions can, therefore, be recorded. The cycles of the visible skin reaction are represented in Table I.

[10] No representation of the time curve of erythema and pigmentation is given as it is very similar to those published by Miescher (Fig. 1).

TABLE II

Time record of erythema and pigmentation after 50 per cent S.U.D.

Time	Erythema	Pigmentation
0 hours	–	–
6 hours	>1	–
24 hours	–	–
2 days	–	–
3 days	–	–
4 days	–	–
7 days	–	>1
9 days	>1	>1
3 weeks	–	1
4 weeks	–	>1
6 weeks	–	?
8 weeks	–	–

2. Exposure with 50 per cent S.U.D.

This group shows practically the same capillary reaction as reported in Part 1; it occurs in a milder form only, and the cycles of the visible reaction could not be differentiated as well. The visible erythema never reached the pronounced red, as observed in the first group. A very slight tanning started on the seventh to the twelfth day, to fade away in the following week. After one month the area of exposure was just recognizable (Table II).

As to the interpretation of these reported observations, it seems very likely that the first stages of capillary reaction to a full

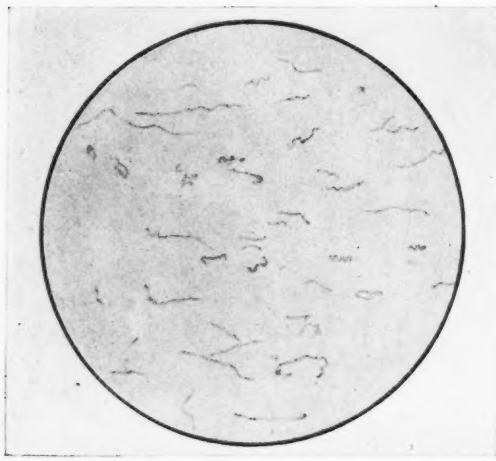

Fig. 13. Six weeks after the exposure.

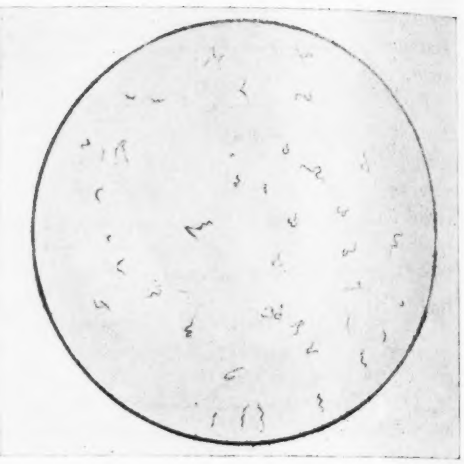

Fig. 14. Two months after the exposure.

dose of unfiltered roentgen radiation represents a paralysis of these small vessels, due to an effect upon the endothelium of their walls, or perhaps to the vasomotor nerves in the exposed area. There is, during that period, a marked rise of the threshold for stimuli, while after return to normal appearance prompt reaction to heat or cold is noted. This indicates that no permanent injury has been done with the dose used here.

Tables I and II show that we were able to confirm the results of Miescher's investigations. The so-called roentgen-erythema not only does appear, as noted in the original definition, seven to ten days after the treatment, but there is in nearly all cases a cycle of reactions to be observed. Even if the three or four cycles are not all macroscopically visible, they always manifest themselves in a well defined capillary change, as increase in size and number of these vessels, with a darker background in the microscope. A careful observation will, however, demonstrate the presence of a very slight surface reaction in the major-

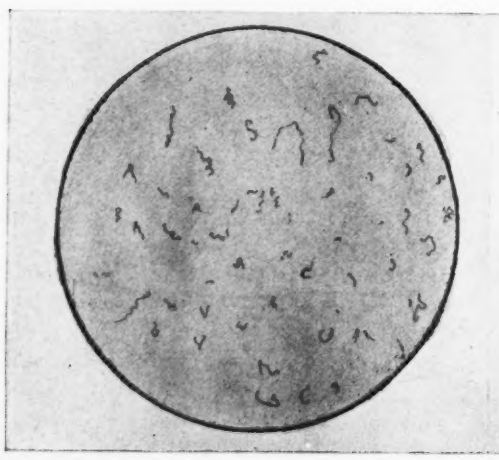

Fig. 15. Ten weeks after the exposure.

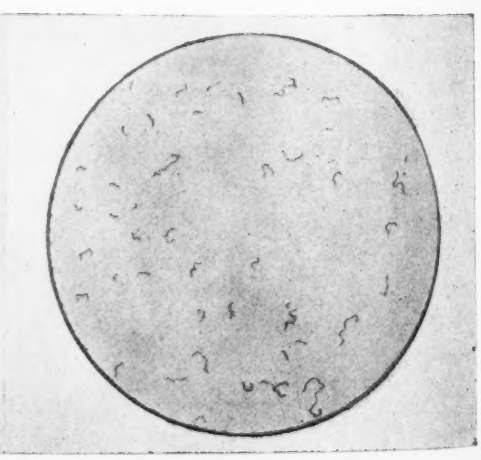

Fig. 16. Three months after the exposure.

ity of cases. A glass plate pressed on the examined part of the skin proves to be of great help.

There is no doubt that our findings, as a whole, may be subjected to the same criticism which holds true for a considerable number of biological tests: the individual error due to the employment of a non-objective method. We have been conservative, therefore, in drawing conclusions from the results of our work.

SUMMARY

(1) The study of the capillaries of the human skin with the skin microscope shows a great variation of their appearance in normal individuals and in different parts of the body. (Mueller, Callander.)

(2) After exposure to $\frac{1}{2}-1$ S.U.D. of unfiltered roentgen radiation very characteristic changes occur in the skin capillaries, as observed by other investigators. (Mueller, David and Gabriel.) Complete *restitutio ad integrum* takes place in one to three months.

(3) The capillary changes run almost parallel to the visible erythema. The latter appears in several cycles or periods. (Miescher.)

(4) This paper is based on observations made in twelve normal adults; the findings were confirmed by examinations of over one hundred patients.

(5) Investigations of the capillary reaction to exposure with filtered radiation of short wave length will be reported in a second paper.

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DISCUSSION

Dr. A. U. Desjardins (Rochester, Minn.): Dr. Pohle's study is very interesting indeed, because, after it has been carried on over a longer period and has covered a larger number of cases, it may prove a means of helping to solve the question of dosage. However, certain considerations lead me to comment on it. Those of you who are familiar with photography are aware of the effect of varying the size of the diaphragm opening of the camera and the time of exposure on the development of the negative. The larger the opening of the diaphragm the shorter the exposure required, but under such conditions, one has little latitude in development. If the diaphragm opening is quite small, the exposure must be much longer, but one gains much latitude in development, not to mention other advantages. In the behavior of X-rays and of radium the same holds true. In treating certain skin lesions with unfiltered rays we have to plan the dose with accuracy, because there is not much latitude between the point of beginning erythema and that of ulceration. But the more filtration we employ the greater the latitude between slight and extreme skin changes. There has been much confusion about dosage units. Some speak of biologic units; others of physical units. There is not so much difference between the two as many

seem to think; because, when we employ a physical unit, the determination of the number of such units to be used depends on the degree of erythema each radiologist decides upon as his dose limit. This he adopts as his own standard. It all comes to the same thing in the end and it really makes no difference whether we speak in terms of a physical or of a biologic unit. I am very glad this study has been undertaken, but, if it is to furnish us helpful information, it must be continued at least five years, because it is well known that skin changes, such as telangiectasis, do not occur until long after the irradiation.

Dr. H. J. Ullmann (Santa Barbara, Calif.): I think those of you who have been using unfiltered radiation have found how useful the arithmetical method is, and I would like to ask Dr. Pohle if, when he spoke of a unit, he meant the arithmetical unit, and, if he did, whether it was one or one and a fourth? That is, whether the formula would read 36/64 or 45/64? It is an extremely useful unit and we ought to know whether he meant that or some other unit. When one speaks of inches in reference to gaps, nobody else can duplicate the work. I have found 9-inch gaps with moderately blunt points, at sea level, to vary anywhere from 130 to 135 kilovolts. To measure voltage in inches gap is equivalent to measuring distance with a rubber band. Let us talk volts, which mean something.

Dr. L. R. Sante (St. Louis): I wish to refer to the supposed favorable action of the ultra-violet ray in cleaning up an overdose of X-ray or permitting the giving of more radiation. It seems to me that if similar experiments were carried on with the ultra-violet ray and with the combination of the ultra-violet and the X-radiation, we might arrive at some more scientific knowledge of what are the actual changes which take place. Until such fundamental work is done, it seems that anything we can do by observation of such inexact things as the erythema dose, which of course varies with the judgment of the various men, will be of no avail. If it is observed that ultra-violet will permit the increased radiation with X-ray and radium, it seems to me that this would be a very great advantage in radiology.

Dr. A. U. Desjardins: I should like to ask Dr. Pohle if he has made any studies of normal skin to see what difference there might be in capillary distribution between the red-haired blonde, straight blonde and the different grades of brunette? That would be very interesting as a preliminary to other work.

Dr. Pohle (closing): I would like to state, first, that I agree entirely with everything Dr. Desjardins has said. This paper I have read to-day treats only of our first and very small step in a long series of investigations on that subject which we intend to do. As mentioned several times in the paper, we have been very conservative in drawing any conclusions. As a matter of fact, we have drawn no conclusions at all but simply described the observations we made. In regard to the terms, kilovoltage or gap, my personal opinion is that we have no kilovolt meter on the market that is so exact that it is very much better than a spark gap. I refer to the tables in G. W. C. Kay's book on X-rays (4th edition, p. 102-3), which give the correction factors for temperature and altitude. I might say that the spark gap used in our exposures corresponds to approximately 135 K.V., measured with the Seemann spectograph. We did not use any formula at all to calculate the erythema dose, but we have applied a dose on experiments originally done on the skin. This dose has been used for nearly four years on this same machine and the same tube for skin therapy, and, from 2,000 cases examined and observed, about 90 per cent showed an erythema of average degree. I can not give a better definition at present because we have none. As far as the effect of ultra-violet radiation on the

capillaries is concerned, we have started investigations of this subject; ultra-violet radiation produces principally the same changes in the skin capillaries, only they disappear much sooner,—in about four to six days. That problem is still under work and we have not come to any definite conclusions. There is still one objection to the method itself, that is the drawing of the microscopical picture, but we are just now preparing an apparatus that will allow us to photograph the capillaries actually, so that the method will be without reproach. We use our findings in practice for one purpose only at present. If we see a patient who has had treatment previously and we want to decide the question of the right interval, we examine the treated part first, and try to define the present character and status of the capillaries. The idea is to determine if they still show the reaction which we know now fairly well, and if they respond as normal capillaries do to heat and cold. This is very important, chiefly in a case that comes from another institution, where we do not know exactly what has been done and do not want to treat again without necessary precautions.

Gastro-intestinal tract and endocrine glands.—The gastro-intestinal tract shares with the rest of the organs of the body in the secondary effects resulting from disturbances in the functions of the endocrine glands, but not to the extent that is often considered. The exact mechanism is not definitely known, but it is probably through both the medium of the autonomic nervous system and changes in the general bodily nutrition.

Slight endocrine disorders seldom produce gastro-intestinal disturbances.

In general, the stomach acidity tends to be lowered by hyposecretion of the thyroid, pituitary and suprarenals.

Hyperthyroidism also tends to reduce gastric acidity, achlorhydria being a frequent finding in exophthalmic goiter cases presenting gastro-intestinal symptoms.

Peptic ulcer is not common in manifest endocrine disease, having been noted only four times in 126 cases.

In endocrine cases in which there is intestinal disorder, the most common lesion is spastic rather than atonic.

In gastro-intestinal cases, all other etiologic factors should be excluded before incriminating the endocrine glands.

W. W. Wasson, M.D.

The Digestive Tract and Endocrine Function. Bruce C. Lockwood. Jour. Am. Med. Assn., Oct. 3, 1925, p. 1032.

X-ray treatment followed by pregnancy.—The author records the case of a woman, aged 27, who was treated for large multiple uterine myomata by nine applications of X-rays at monthly intervals. Severe dermatitis followed, and menstruation became somewhat less profuse. Five years later the patient was delivered spontaneously of a recently deceased fetus, and the three myomata which were still present became rapidly smaller during the puerperium. The myomata had enlarged three years later when the patient was again pregnant; this pregnancy, in spite of the existence of a marginal placenta prævia, terminated in the extraction by forceps of a live child weighing 9 pounds 10 ounces.

At least ten other observations have been recorded of normal pregnancy and delivery following X-ray treatment for uterine myoma, and it has been proposed to treat amenorrhea and ovarian hypofunction by small doses of X-rays. On the other hand, a number of abortions and fetal deaths have been reported, and there is experimental evidence that the developing follicular cells and ovocytes are particularly sensitive to X-rays.

Pregnancy after X-ray Treatment. E. Gaujoux. Bull. Soc. d'Obstét. et de Gynécol. de Paris, No. 8, 1925, p. 589. (Reprinted by permission from Brit. Med. Jour., Nov. 7, 1925, p. 70 of Epitome of Current Medical Literature.)

RADIO-ACTIVE SUBSTANCES AND THEIR THERAPEUTIC USES AND APPLICATIONS

RADIOTHERAPY OF CANCER OF THE UTERINE CERVIX

By JOSEPH MUIR, M.D., New York

VI. AUTHOR'S TECHNIC

ONE of the greatest triumphs of radium therapy is its simplicity. The patient may be snatched from the very jaws of death by a procedure which offers no greater technical difficulties than a diagnostic curettage. This simplicity extends—or perhaps I might better say *should be extended*—to the nomenclature of its clinical practice. All too often, in discussing the therapy of cancer of the uterine cervix, we find the classification of cases into "operable" and "non-operable," subdivided into such classes as "early," "moderately advanced" and "advanced," and frequently even further subdivided, until, the ramifications extending more and more widely, the reader's mind becomes exhausted in the futile endeavor to keep these multitudinous differentiations clear in his perception.

An elaborate schedule of application separately enumerated for each different phase of the varied manifestations of cervical malignancy is not only unnecessary, but actually serves to confuse the practitioner who is seeking for practical guidance in a new procedure, and by increasing the difficulties of application may serve to lessen the value of the treatment—may even in a few cases deprive a patient of the benefits to be gained from radium, because her medical attendant is afraid to undertake to administer what appears to be so technically formidable a therapy.

Inasmuch as my subject is radiotherapy, I am automatically relieved of the necessity of distinguishing between operable and inoperable neoplasms of the cervix. In describing the technic of application which has been gradually evolved ever since the therapeutic possibilities of radium were first recognized and its effects observed in malignant conditions of the cervix uteri, I shall make only such classifications as are necessary to distinguish between those cases where the canal lies open—making application a comparatively simple matter—and those where the growth has advanced so far as to occlude the canal, and force us to employ palliative measures until such time as the affected area can be made ready for the proper application of the curative dose.

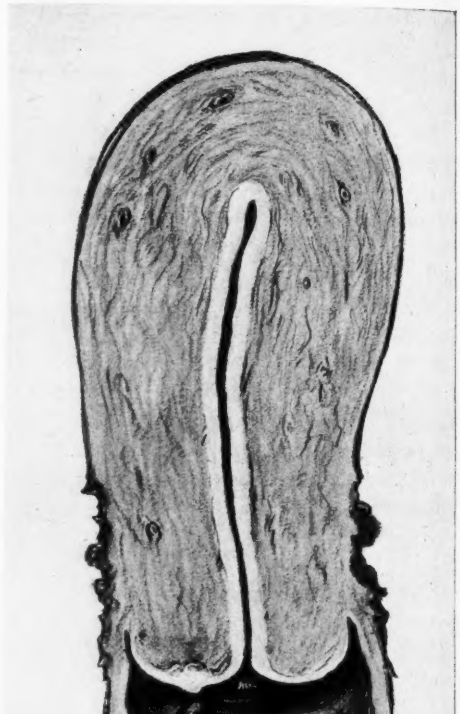

Fig. 1. Canal entirely patent.

In the review of American and foreign methods of applying radium to the uterine cervix which preceded this present paper, many widely varying opinions were set forth and a number of markedly different methods of technical employment described. The conflict between some of them would, at first thought, seem irreconcilable, but a more mature consideration will show us that a few fundamental principles lie at the basis of every system of radiotherapy, and that the continual advance in the technic of treatment with this element has only confirmed the earlier observations upon the necessity of building every technical superstructure upon these fundamentals.

Foremost among these is the absolute necessity of regarding radium application in the light of a major operation, fully as serious as the hysterectomy which, in many cases, it has superseded. The factors of preliminary preparation, of rigid asepsis, of the prevention of post-operative shock and the avoidance of remote sequelæ, loom just as large in radium treatment as in the performance of any of the well-recognized surgical procedures, and unless the work can be undertaken with full cognizance of its gravity and serious import, it had far better not be undertaken at all. A patient improperly treated with radium is likely to be in a far worse condition than one who has been made a victim of unskillful surgery. On the other hand, the application of radium is mastered with ease by any intelligent practitioner, even if he has not had the special training in gynecology which is so highly desirable for one undertaking to treat carcinoma of the uterine cervix, and the technical difficulties should not daunt anyone who has the best interests of his patients at heart. Once resolved to carry out the treatment with all due regard to the factors of safety, which are at present so well understood as to afford no excuse for ignorance or misapplication in any direction, there is no reason why every woman suffering from cervical carcinoma should not be given the chance of life and health which radium is now able to hold out to her.

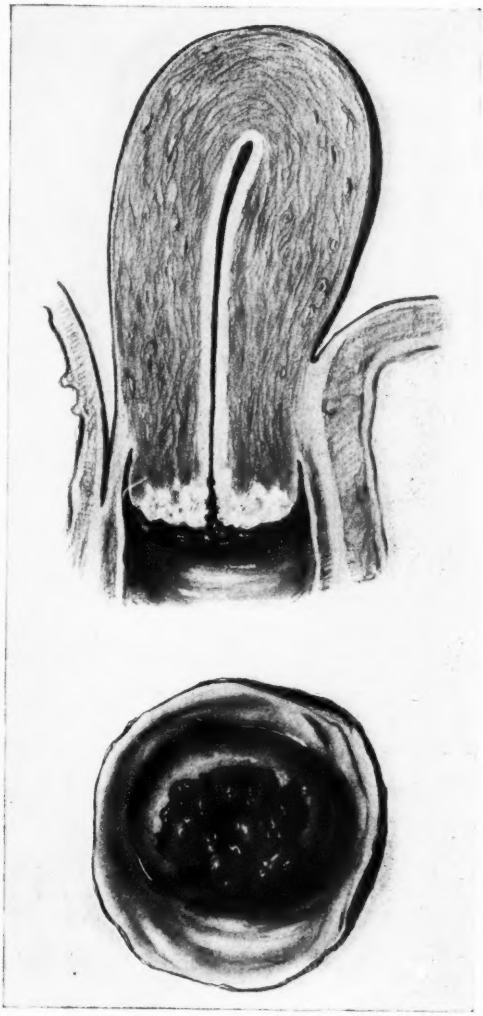

Fig. 2. Moderately advanced carcinoma; some preliminary radiation necessary.

In the development of the details of our technic we have in most instances followed closely in the footsteps of the French practitioners who have from the outset been in the foremost ranks of practical radium therapists. Yet we have felt free to improve upon their methods whenever "Yankee ingenuity" has shown a better or more expeditious way, and have thus gradually built up a technical plan of our own which

we believe combines the best features of all that has preceded it, while at the same time much has been eliminated which experience has shown to render any of the older methods less effective and reliable. The three cardinal principles of this therapy are:

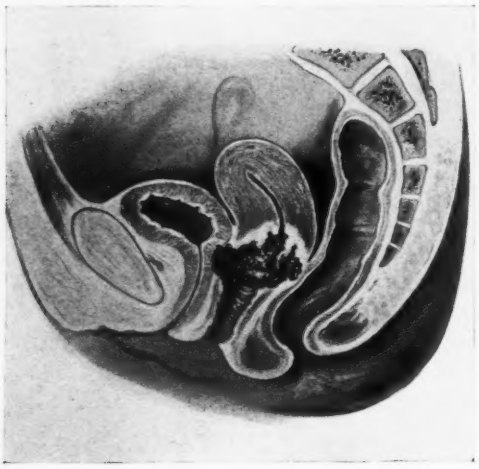

Fig. 3. Canal completely occluded.

(1) Rigorous asepsis; (2) proper distribution of the highest possible dosage which can be applied without injury to the surrounding normal tissues, and (3) the avoidance of necrosis by proper filtration. When these three requirements are faithfully fulfilled, we are confident that radium will render all the curative aid possible in any given case, and that the results, even when the conditions are such that but little hope can be held out, will more than justify the high expectations which must so often be pitifully abandoned after insufficient or improper radiation.

Preparation of patient: To get the full benefit of radiotherapy the patient must be as carefully prepared as for a major gynecological operation. Rectum and bladder must be fully inspected, and a test of kidney function is desirable in any case where there is the least shadow of doubt as to the ability of these organs to cope with the waste products which will be induced by the radiation of the neoplasm. All the other pre-operative considerations must be taken up and disposed of with exactly the same attention that would be regarded as necessary before the performance of a hysterectomy or similar procedure.

Immediately before the radium application is to be made, the external genitals are shaved and rendered as aseptic as possible. Absolute alcohol is the best disinfectant for washing out the vagina and uterus. Throughout the treatment it should be borne in mind that the use of iodine and iodoform gauze is emphatically contra-indicated.

Aseptic precautions during the course of the treatment are equally important. Every day the radium applicators are to be removed, thoroughly sterilized and replaced with the same care which was originally observed. It is impossible to lay too much stress upon the importance of these aseptic precautions.

Preliminary radiation by bare tubes may be necessary in those cases where the growth has proliferated to such an extent as to occlude the cervical canal. These tubes should be implanted in accordance with the technic already described in the preceding papers relating to other malignant lesions.

Importance of early treatment: It seems hardly necessary to add that it is most desirable to institute the radium treatment *before* the growth has had time to proliferate to an extent which makes this preliminary treatment imperative. Unfortunately, neither patients nor the average practitioner are as yet alive to the necessity of early application of every sort of curative effort in attempting to combat cancer of the cervix. Despite all that has been said and written, the radium therapist is continually presented with cases which are so far advanced before they were even brought to the attention of a medical man, as to be beyond any kind of aid. Moreover, radium is still too much regarded as a last resort, to be employed only when all other hope is gone. The success of radiotherapy, even under these trying conditions, has proved

little short of marvelous, but until it has had a fair trial upon lesions still early enough to offer conditions favorable to satisfactory treatment, we will be unable to make any positive assertions as to its actual curative powers.

Dilatation of the cervical canal: For those cases where the cervical canal is still patent, or after preliminary "seeding" has opened an occluded canal, we have devised a special set of applicators which afford adequate and thorough radiation of the entire malignant area. These applicators should, if possible, be introduced without dilatation of any kind, but as this is seldom possible, bougies should be used with the utmost caution, always bearing in mind the great friability of malignant tissue and the danger which will attend any trauma to the affected area. In the words of de Nabias: "There is nothing more easily traumatized and resistant to distention than a neoplastic cervix; so if force is used, the tissue is likely to be fissured at the insertion of the cervix, thus opening up communication between the highly septic cervico-uterine cavity and the cellular tissue at the base of the broad ligament. This might easily induce phlegmon of the broad ligament and pelvic peritonitis, with an almost inevitably fatal outcome. This supplies the reasons for some of the disasters which have in the past attended such manœuvres, for such a dilator, once in place, inexorably enlarges the orifice to a standard size; if the cervix has not been extensively invaded by the neoplasm, it may stretch to this caliber without accident, though a crack or other inadvertent lesion may later appear. This serves to emphasize how many of the accidents for which radium is held responsible should really be charged up to the imprudent method of dilatation." The only safe method is the introduction of gradually larger dilators of the bougie type; the Goodell dilator should never be used—it is far too liable to cause serious, or even fatal, trauma.

Necessity of wide distribution of radio-active centers: To accomplish our second requisite—the proper distribution of the highest possible dosage which can be applied without injury to the surrounding normal tissues—we have found it necessary

Fig. 4. Advanced carcinoma; extensive preliminary radiation indicated.

to employ a relatively large number of centers of activity, so as to bring the entire cervical region, as well as those adjacent tissues where recurrence or extension is of so frequent occurrence, under the influence of the therapeutic rays.

Packing: The proper packing of the vagina after the applicators are in position is a most important part of the procedure. This should be done with plain aseptic gauze, first introducing about two feet of this material in the posterior part of the vagina in the general direction of the rectum. More packing is then put into the vesical area, thus protecting both bladder and rectum from too close exposure to the radio-activity. It should be an invariable rule that all extra-uterine applicators must be kept at a distance of at least one centimeter from the rectal and vesical walls. More packing is put in below, with the idea of pushing the entire uterus upward beyond both bladder and rectum, in this way lessening the danger to these adjacent organs. The dressing is completed by the applica-

tion of a T-binder, and the patient put at rest for twenty-four hours. The application is continued for six days, the applicators and packing being removed each day, the applicators sterilized and the vagina repacked—all under the strictest asepsis.

Dosage: The dosage which we employ has been criticized by some of our colleagues as being extremely high, and comparison with the therapy recommended by other American clinics, which we reviewed in a previous paper, will, indeed, show that the amount we use is considerably in excess of that recommended by a number of gynecologists and radium therapists. In reply to such criticisms, however, we have a number of times quoted the assertion of Régaud, the associate of Madame Curie, that in the treatment of cervical cancer "it is essential to give the strongest dosage which will leave the normal tissues uninjured, taking into especial consideration the sensitivity of the vaginal mucosa." The proof as to the wisdom of using this dosage rests, in the last analysis, upon the outcome of our cases, and with them we can with perfect confidence leave the answer to this question.

The entire amount used is from five to ten thousand millicurie hours, varying according to the nature and stage of advancement of the lesion under treatment. This is widely distributed among multiple centers of radio-activity, for the purpose of giving equal distribution throughout the entire malignant area, and is applied for a time period of from six to ten days.

In considering the question of dosage we must not lose sight of the principle that for therapeutic use we desire to segregate the so-called "hard" gamma rays—those of the shortest wave length. The best clinical results follow the application of a technic which eliminates completely the undesirable beta rays, as well as the less penetrating "soft" gamma rays.

Filtration: Though mentioned last in our list of fundamentals, filtration thus becomes by no means least in importance. In fact, it is only by the most painstaking arrangement of this highly essential adjunct to radium therapy that success is in any way possible. As has been repeatedly pointed out in discussing the radiotherapy of other parts of the body, satisfactory end-results depend almost wholly upon the prevention of necrosis in the tissues about the centers of radio-activity—or, in other words, the elimination of the caustic beta rays—while at the same time the effect of the gamma rays is in no way lessened. Toward the accomplishment of this end, all radium therapists have labored ever since the element had its first therapeutic application. The danger of necrosis is abolished by a screenage consisting of a combination of 4 mm. of platinum—a metal which has proved to be the most efficient filter for the caustic rays; of aluminum foil, an agent serving to eliminate the secondary beta radiation given off from the platinum screen, and a final outer covering of rubber which contains no metallic element. When the containers so screened are placed in the cervical canal and within the uterus itself, even with the high dosage which we advocate, there is no danger of necrosis, and by rigid attention to every technical detail the radio-activity will be dispensed to the best advantage and will be capable of accomplishing the utmost good possible in any given case.

Post-operative recurrences: For those cases of recurrence after surgical extirpation when it is desired to resort to radium therapy, or where radium is applied as a post-operative precaution, the technic is in the main similar to that described for advanced primary cases. If the recurrence is in the cervical stump, the best procedure is the implantation of radium emanation "seeds" with platinum filtration; six such seeds, each containing 2.5 millicuries of radium emanation, being implanted at equal distances about the cervical stump, not less than two centimeters apart. No attempt is made to recover these seeds, and at the end of thirty-three days the emanation will have decayed completely, and will have provided 2,000 millicurie hours of

radiation. In recurrent cases, radiation of the canal is also desirable. For this, there should be at least two centers of radio-activity, totaling some thirty millicuries of radium emanation, and these vaginal applicators should be kept in place for eight days, thus providing 3,000 millicurie hours of radiation. The same aseptic precautions, the daily removal and sterilization of the applicators, and repacking of the vagina should, of course, be observed as in the treatment of primary growths. The total dosage from the "seeds" and the vaginal applicators should finally reach 5,000 millicurie hours.

When the radio-active centers are inserted in the vagina they should be so placed as to approximate the region of the broad ligaments, but each succeeding day they should be rotated—as the clock hands move—a space sufficient to insure an equal intensive radiation of the entire circumference of the cervix by the conclusion of the period of treatment. In this way not only the site of recurrence, but the adjacent tissues—which in all probability harbor malignant "rests"—will have been thoroughly exposed to the therapeutic rays. This procedure has proved satisfactory in dealing with recurrence after surgery, though the necessity of awaiting a five-year period of freedom from all signs of malignancy makes it impossible for us at present to estimate fully its true worth. We are, however, fully convinced that up to the present time, no technic of treatment has been devised which so nearly reaches the ideal of satisfactory radium therapy.

CONCLUSION

It has seemed appropriate to devote a relatively large part of this series of articles upon the use of radio-activity to the consideration of its application to cancer of the cervix, because—as was said at the beginning—radium has always found its highest usefulness in the attempts to combat the ravages of this prevalent and much-to-be-dreaded lesion peculiar to the female sex. Moreover, the most recent developments in radium therapy have been especially applicable to the treatment of cervical cancer, and there seems to be somewhat of a dearth of information in recent American publications concerning these newest devices. There was apparently need of a general review of the work upon cervical cancer so far accomplished in this country, and a forecast of what we have reason to hope for in the future. To say anything in the nature of a "final word" upon the subject is manifestly impossible. Hardly a day passes without some improvement being made in technic, some better mode of application being devised, or some histologic or biologic investigation being made which enables us to exploit to still greater advantage the resources already at our command. Gynecologists and radiologists alike can look backward along the toilsome path already traveled, feeling that their labor was not in vain, and forward toward almost unlimited possibilities of conquest in a field of therapy where the stoutest champions have heretofore almost universally been overwhelmed by ignominious defeat.

EXTREMITY TECHNIC

By E. C. JERMAN, Chicago

FOLLOWING the proper calibration of an equipment, it should be carefully charted for the various regions of the body and for the various technics which it may be desired to use.

The two following tables are to be used as a guide in charting for extremity work, one with the use of *double screens* and the other without screens. The first step is to fill in the A.T.V. (autotransformer or pre-reading voltage) column of both tables with the necessary pre-reading voltage for each K.V.P. (kilovolts peak) shown. These various pre-reading voltages may be obtained from the calibration chart. A variation of 2 or 3 K.V.P. or 2 or 3 pre-reading volts is not material. A variation of more than 5 K.V.P. or A.T.V. ought to be avoided if possible. Example: The calibration chart may show that 125 P.R.V. are necessary in order to produce 87 K.V.P. at 20 milliamperes. It may be found impossible (by any manipulation of the autotransformer) to obtain exactly 125 A.T.V. Then get the nearest to 125 that may be possible, anywhere from 122 to 128.

A 36-inch distance is suggested in order to place the high tension at a greater distance from the patient, to bring about a better detail result, and to provide a longer exposure time. A five-second exposure time may be more readily and accurately duplicated than a one-second or a fractional-second exposure time, especially if an accurate time switch is not available.

TABLE I

Normal medium size subject with film and double screens [1]

		10 ma. 5 sec.		10 ma. 1 sec.		20 ma. 2½ sec.		30 ma. 1 sec.		100 ma. 1/10 sec.	
Region	Pos.	P.R.V.	K.V.P.	P.R.V.	K.V.P.	P.R.V.	K.V.P.	P.R.V.	K.V.P.	P.R.V.	K.V.P.
Wrist	Lat.		51		67		51		49		67
Wrist	P.A.		46		62		46		44		62
Elbow	Lat.		58		74		58		56		74
Elbow	A.P.		55		71		55		53		71
Shoulder	A.P.–P.A.		68		84		68		66		84
Ankle	Lat.		55		71		55		53		71
Ankle	A.P.		58		74		58		56		74
Knee	Lat.		61		77		61		59		77
Knee	P.A.		65		81		65		63		81

TABLE II

Normal medium size subject with film, without screens [1]

		10 ma. 10 sec.		10 ma. 5 sec.		20 ma. 2½ sec.		30 ma. 1¾ sec.	
Region	Pos.	P.R.V.	K.V.P.	P.R.V.	K.V.P.	P.R.V.	K.V.P.	P.R.V.	K.V.P.
Wrist	Lat.		50		54		54		54
Wrist	P.A.		46		50		50		50
Elbow	Lat.		57		61		61		61
Elbow	A.P.		60		56		58		58
Shoulder	A.P.–P.A.		74		78		78		78
Ankle	Lat.		54		58		58		58
Ankle	A.P.		57		61		61		61
Knee	Lat.		67		71		71		71
Knee	P.A.		70		74		74		74

A 25-inch distance is suggested, when no screens are used, in order to avoid the use of the higher gap or voltage or of a too long exposure time.

A ten-milliampere technic is suggested in order that the finer detail to be obtained with the use of the smaller focal spot of the five-ten radiator tube may be made available. The 20 and 30 milliampere technic may be used with the five-thirty radiator tube or the fine focus universal tube, but should not be used with the five-ten radiator tube.

The five-second technic is suggested in order that a considerable contrast may be provided. A one-second technic is suggested for those patients who find it difficult to hold still for a five-second period. A 100 milliampere 1/10 second technic is suggested for use with struggling children or nervous individuals where the maximum speed becomes a necessity.

To use the 100 milliampere 1/10 second technic satisfactorily an accurate time switch becomes a necessity, in order that the time factor may be readily duplicated, and a stabilizer adds much toward duplication of the milliampere factor. The five-ten radiator tube should be used only with the ten-milliampere technic. The five-thirty radiator or the fine focus universal tube may be used with the 10, 20, 30 or 100 milliampere technic for extremity work.

THE USE OF THE TECHNIC CHART

On account of variability in speed of films, in speed of screens, or of the size or thickness of the part to be exposed, of the

[1] Dist. = distance. K.V.P. = kilovolts peak. Ma. = milliamperes. Sec. = seconds or time of exposure. P.R.V. = pre-reading or autotransformer voltage. Lat. = Lateral position. A.P. = Anterior position. P.A. = Posterior-anterior position. In preparing these tables, Patterson double screens and Eastman duplitized films were used.

transparency or opacity of the part to be exposed or of pathological conditions, any chart that may be prepared can be used only as a starting point. The technician, after viewing the part to be exposed, should use his best judgment regarding any variations from the chart. His judgment or skill will improve rapidly with practice and experience, if the chart be constantly used as his guide. When the part to be exposed has been placed in proper position, he should decide upon the technic to be used. He may use the 10 ma.–5 sec., 10 ma.–1 sec., 20 ma.–2½ sec., 20 ma.–1 sec., 30 ma.–1 sec., or 100 ma.–1/10 sec., with screens, or the 10 ma.–10 sec., 10 ma.–5 sec., 20 ma.–2½ sec., or 30 ma.–1¾ sec., without screens.

After the technic has been selected for a given subject, the film, screen, distance, time and milliampere factors should be kept constant. With the above factors fixed, with a given subject, there is but one P.R.V. (with its corresponding K.V.P.) that will give the best possible result. The problem is to find that P.R.V. (and corresponding K.V.P.). Example: Subject, a lateral knee, technic selected, 10 milliampere–5 second, 36-inch distance, with screens. If the knee is an average medium size, by reference to Table I, it will be found that 55 K.V.P. (you will have determined already the necessary P.R.V. for that K.V.P.) is to be used. If the knee is larger than medium, use a higher P.R.V. (K.V.P.), and if it is smaller, use a lower P.R.V. (K.V.P.). When the exposed film has been developed it will be at once apparent whether or not a higher or lower P.R.V. (K.V.P.) should have been used for that subject. If the radiograph is too dark, a lower P.R.V. (K.V.P.) should have been used. If too light, a higher P.R.V. (K.V.P.) should have been used. If it is desirable to improve the density, another exposure can be made. The second guess should be better than the first.

SUMMARY

The tube, the film, the screen, the milliamperage, the distance and the time factors are all fixed when selecting the technic to be used, and should then remain constant. The pre-reading voltage (K.V.P.) factor is to be manipulated for the purpose of obtaining the desired result. In routine practice, after selecting the technic to be used with a given subject, it is necessary for the technician to decide only what pre-reading voltage should be used. The K.V.P. may be eliminated except when it may be desired to impart or receive information to or from others regarding the voltage or penetration factor value. A given K.V.P. means the same value, when properly measured, wherever it may be used and with all equipment. A given pre-reading (autotransformer) voltage may have one value with one equipment and another value with other equipment. Consequently, the pre-reading voltage required to produce given K.V.P. values must be worked out with each individual equipment with a sphere gap.

CASE REPORTS

DOUBLE GALL BLADDER [1]

REPORT OF A CASE

By B. H. NICHOLS, M.D., Cleveland Clinic, CLEVELAND, OHIO

In 1916, Dr. August Schachner, in an article entitled "Anomalies of the Gall Bladder and Bile Passages,"[2] called attention to the fact that a knowledge of such anomalies was essential to the surgeon and that very few cases have been reported.

Fig. 1. Roentgenogram of double gall bladder showing two distinct rows of stones.

The list compiled by him included only five cases of double gall bladder and three of these were found at autopsy. So far as I have been able to discover, no later reports regarding this anomaly have appeared in the literature and for this reason it has seemed to me that the following case history may be of interest.

CASE REPORT

The patient was a physician 51 years of age who came to the Clinic, December 3, 1925, because of pain in the upper right quadrant of the abdomen. He reported that during 1916 and 1917 he had had several attacks of pain in the right hypochondrium, which usually came on at night, starting with a feeling of distress and gradually increasing until the agony was severe. These attacks were relieved by castor oil. The pain was localized but was unaccompanied by jaundice or by any alteration in the appearance of the stools or urine. After 1917 he had no further attacks until August, 1925, when an attack occurred, the type of which was much the same as those which had occurred nine years previously. In October he again had an attack, so severe that castor oil was of no avail and morphine was required for relief. This attack, unlike those which had preceded it, was accompanied by jaundice which reached its maximum in about two days and then gradually disappeared. The stools were very pale in color and the urine was very dark colored. The pain recurred on the second day.

The significant findings in the physical examination were the presence of definite tenderness in the gall-bladder region. There was no rigidity; no mass could be palpated; there was no hernia. The patient reported at the time of admittance to the Clinic that he had lost ten pounds in weight since October. The chief impression gained from the history and the examination was that gallstones were present, although chronic appendicitis was also suspected.

X-ray examination disclosed two distinct rows of stones in the gall-bladder region,

[1] Received for publication, January 4, 1926.
[2] Ann. Surg., 1916, LXIV, 419-433.

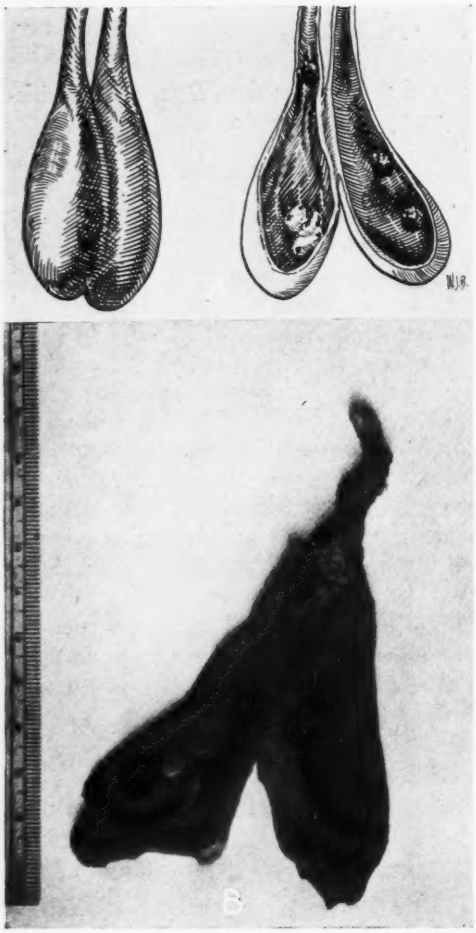

Fig. 2. Double gall bladder: *(A)* Drawing showing separate pouches and ducts; *(B)* pathological specimen showing two stones in each sac and one stone in the neck of one of the sacs.

which could not be approximated by manipulation of the gall bladder (Fig. 1).

At operation a double gall bladder, showing two distinct pouches, was removed. The pathological examination showed that when the two pouch-like structures, which were joined by connective tissue, were dissected, the dissection being carried toward the neck, there were two separate and distinct gall bladders, each of which had its own cystic duct opening either into a common cystic duct or separately into the common duct. The walls and the mucosa of each of these gall bladders were thickened and each contained black, rough stones the size of a pea, one stone being wedged into the neck of one of the sacs (Fig. 2 B).

KIDNEY STONES: REPORT OF CASE[1]

By JOHN S. DERR, M.D., ATLANTA, GEORGIA

Male, white, age 42, weight about 220 pounds. The patient was a man of strong, robust appearance, who had complained of soreness on the right side for years, but had had no acute attacks of pain. Examination

Fig. 1.

of the urine revealed the presence of pus. X-ray examination on April 4, 1924, showed the condition seen in Figure 1—a much enlarged right kidney almost completely filled with overlapping masses of stones, arranged in two groups, that in the upper pole being somewhat smaller. No stones were seen in the ureters or the left kidney.

[1] Received for publication November 13, 1925.

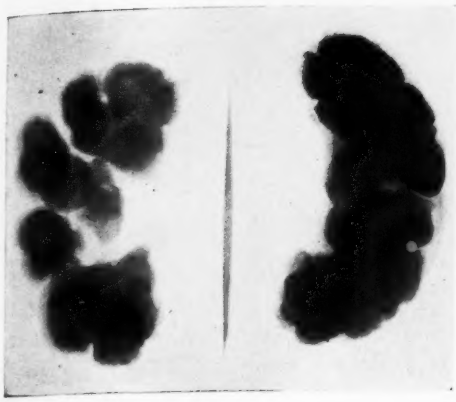

Fig. 2.

Operation was performed one year after the initial X-ray examination, on June 4, 1925, by Dr. Willis Jones. Figure 2 shows the right kidney in two positions, after removal.

RECURRING MUCOUS CYST OF THE STOMACH: REPORT OF A CASE

By JOHN D. CAMP, M.D., Assistant Roentgenologist, Massachusetts General Hospital, Boston, Mass.

Benign tumors of the stomach, while uncommon, are not rare. Of these, fibromyoma, leiomyoma, adenomyoma, simple myoma, hemangioma, adenoma and polypi seem to be most common. The apparent rarity of mucous cyst of the stomach seems to justify the report of the following case.

A boy seven years of age was admitted to the hospital December 22, 1924, complaining of vomiting and diarrhea, of six weeks' duration. The past history and family history were essentially negative. He had been perfectly well until six weeks previously, when he began to vomit and have diarrhea. This persisted despite changes in diet. No blood had been noticed in the vomitus or stools.

The physical examination revealed a poorly nourished and poorly developed boy. In the right upper quadrant, somewhat to the midline, could be palpated a

Fig. 1. Deformity of the greater curvature of the stomach in the pyloric and pre-pyloric regions, produced by a cystic tumor of the stomach.

mass about 4 cm. in diameter, which was tender to deep pressure and freely movable. Otherwise the physical examination was essentially negative.

He was put to bed for twenty-four hours and given a soft diet which he did not regurgitate. Two days later he vomited a small amount of his breakfast. The temperature was normal and the urine and blood findings essentially negative.

A roentgenologic examination showed the stomach to be in the normal position. The curvatures appeared smooth and freely movable. Peristalsis was normal. There was no retention from the motor meal and the first portion of the duodenum appeared normal in contour. There was a palpable mass about 4 cm. in diameter adjacent to the greater curvature in the region of the pylorus. The mass moved with the stomach and the greater curvature appeared to be smoothly indented by it (Fig. 1). This was most marked in the prone position. Normal gastric rugæ were present. The roentgen findings suggested an extra-gastric

Fig. 2. Appearance of the stomach following the operative removal of one cyst and drainage of the other. Pyloric and pre-pyloric regions are practically normal in appearance. Some dilatation of the first portion of the duodenum.

Fig. 3. Deformity of the greater curvature of the stomach, in the pyloric and pre-pyloric regions, produced by recurring mucous cyst.

tumor or a tumor attached to the walls of the stomach.

An abdominal exploration was performed December 31, 1924. On delivering the stomach a cystic tumor was seen on the posterior wall near the greater curvature and just proximal to the pylorus. This was dissected out and proved to be a thin-walled cyst filled with glairy mucus. There was a second cyst on the posterior wall of the stomach about one and a half inches in diameter, filled with the same material. No connection between the cysts and the lumen of the stomach could be demonstrated. The opening resulting from the removal of the first cyst was closed. The second cyst was drained with a cigarette wick and the stomach caught up at the lower end of the incision.

Following the operation a mucoid material discharged from the wick. The amount of discharge gradually became less and the wound closed without incident.

A second X-ray examination was made nineteen days after the operation. At this time there was some spasm in the region of the pylorus and a slight irregularity on the greater curvature near the pylorus, thought to be due to adhesions (Fig. 2). The pyloric sphincter appeared regular. There was a very small retention of barium in the stomach at the end of six hours. The first portion of the duodenum was normal in contour, but slightly dilated.

The patient was completely relieved of his vomiting and was discharged from the hospital January 29, 1925.

He was readmitted June 3, 1925. Since his discharge in January he had been perfectly well and gained much in weight. Ten days before the second admission he began to vomit, with increasing severity, so that at the time of admission he was unable to take any food without regurgitating most of it. The mother had noticed the reappearance of a mass beneath the

site of the operative scar. On physical examination a hard mass about the size of a hen's egg could be palpated beneath the old incision. It was movable and not tender.

An X-ray examination at this time showed a rounded filling defect on the greater curvature of the stomach corresponding to the palpable mass, in the region of the pylorus and first portion of the duodenum (Fig. 3). The mass moved with the stomach, which was somewhat limited in mobility. Peristalsis did not pass over the involved area and there was a retention of about one-third of the motor meal at the end of six hours. The portion of the stomach above the defect appeared normal and peristalsis was present. The X-ray findings were those of gastric neoplasm or a neoplasm extrinsic to the stomach and attached to its walls.

At operation numerous adhesions between the omentum, transverse colon and abdominal wall were found. In the pyloric end of the stomach was a rounded tumor which was firmly adherent to the transverse mesocolon. The tumor and the pyloric end of the stomach were movable. The muscular wall of the stomach spread smoothly over the tumor except at its apex, where it was translucent. It measured about two and a half inches in greatest diameter and was situated directly over the pyloric ring towards the inferior margin of the stomach. Although the lumen of the pylorus was not completely occluded it was largely obstructed by the mass. The mass was dissected free from the transverse mesocolon and the gastro-colic omentum, and could then be delivered. The muscular tissue spread over it was incised and a plane of cleavage found between the cyst and the submucosa of the stomach, from which it was easily removed. There remained after the closure a small defect about one and a quarter inch in diameter in the muscular wall of the stomach and duodenum. The center of this defect was at the pyloric ring so that it resembled a Rammstedt operation. The wound was closed without drainage.

The pathologist described the specimen as a plum-sized cystic tumor with a smooth outer surface. On section it was found to be composed of two chambers filled with thin, clear, sticky fluid. The inner surface was smooth. The wall of the larger chamber measured 4 mm. in thickness and had a white surface on section. The smaller chamber had a much thinner wall. On microscopic examination the cyst showed a structure of atrophied mucous membrane, like that of the gastro-intestinal tract. The walls contained longitudinal and circular layers of well developed smooth muscle. The structure was considered consistent with a diverticulum or a cyst formed from the stomach. A small gland attached to the specimen was found to be normal.

The patient made an uneventful recovery, his vomiting was completely relieved and he was discharged from the hospital in June, 1925.

EDITORIAL

THE RANGE OF RADIOLOGY

The word "radio" has come to mean communication by means of electro-magnetic waves, meters to kilometers from crest to crest, and with a frequency of thousands to millions per second, the longer the wave the less the frequency per second. The word "radiologist" has come to mean an individual interested in the diagnostic and therapeutic use of electro-magnetic waves, so small a fraction of a centimeter from crest to crest that, were a centimeter as large as the circumference of the earth, the waves would be equivalent to little ripples on the surface of the ocean from 4 millimeters (1/6 inch) to 12 centimeters (4.7 inches) from crest to crest and with a frequency per second so great that, were the number of waves only 31,700 per second, it would take from eight to three hundred million years to equal it. Midway between the region of the electro-magnetic waves in which the radio-fan takes interest and the region of those in which the radiologist takes interest comes the region of the electro-magnetic waves which convey energy from the sun to the earth and upon which all life depends. In the center of this region come the rays which, falling upon the retina, give us vision, the rays of light. It is customary to measure the length of the waves in these rays in hundred millionths of a centimeter, Ångstroms (Å.), and their frequency per second by 10^{12}, millions of millions. The wave length of these waves varies, in round numbers, from 7,500 Å. to 4,000 Å. Wave frequency per second varies, in round numbers, from 400 to 750 million millions. On one side of the visible spectrum we have the infra-red region, with longer waves and lower frequency; on the other side the ultra-violet region, with shorter waves and higher frequency.

Thus we have in the spectrum of electro-magnetic waves three main regions, that of the radio, that of the sunlight, and that of the X-rays and gamma rays. Between these regions of direct practical as well as of scientific interest, there are regions of the spectrum, the study of which is beset with difficulties and which at the present time are chiefly of interest to professional scientists. The region between the ultra-violet rays of the sunlight and the X-rays, used by the practical radiologist, has been bridged by scientific study extending from both directions. The region between the infra-red rays of the sunlight and that of the shortest waves used in wireless communication has likewise been similarly bridged. Millikan[1] has recently discovered a new type of rays, "cosmic rays," of shorter length and higher frequency than the gamma rays.

From the biological aspect there are at present no known direct effects on the body by the rays of the radio region of the electro-magnetic spectrum. The tissues of the body appear to be not at all attuned to electro-magnetic disturbances of the frequency commonly used in wireless communication. Advantage is taken of this in diathermy. Here the electro-magnetic waves from the oscillator, of a frequency similar to that of the radio, give up their energy to a resonator placed near enough also to be affected by inductance. From the resonator oscillating currents are sent through the body. There is no direct stimulation either of muscle or nerve nor are the chemical changes which we are accustomed to

[1] Science, 1925, LXII, 445.

TABLE I

RANGE OF WAVE LENGTH AND WAVE FREQUENCY OF ELECTRO-MAGNETIC WAVES

Velocity in space 300,000 kilometers (186,300 miles) per sec.

Order of magnitude	Type	Range octaves	Longest wave length	Frequency per sec.	Comparative data
Supra-terrestrial	Alternating current generator	15	1,000,000 K.M. 621,400 mi.	0.3	1,000,000 K.M. = 2½ times distance to moon; 1/150 to sun.
to ordinary	Wireless	10	30 K.M. 19 mi.	10,000	Sound waves 20 to 30,000 per sec.
terrestrial	Shorter hertzian	16½	30 M. 98 ft.	10 million	
Microscopic	Infra-red	8½	0.3 M.M. $\frac{1}{100}$ in.	1,000,000 million	1,000,000 ν equals number of seconds in 31,700 years.
Colloidal diameters 10,000 Å. to 10 Å.	Light	1	0.00075 M.M. 7,500 Å $\frac{30}{1,000,000}$ in.	400 million ν	Diameter R.B.C. 0.0007 cm.
Ultra-microscopic diameters to 40 Å.	Ultra-violet	5	0.0004 M.M. 4,000 Å. $\frac{16}{1,000,000}$ in.	750 million ν	Cell nucleus photographed with 2,800 Å.
Molecular diameters 10 Å. or less	Very soft X-rays	6	100 Å. $\frac{0.4}{1,000,000}$ in.	30,000 million ν	Radius of atom 1 Å. = 1/100,000,000 cm.
Atomic diameters 2 Å + —	X- and γ-rays	5	1.5 Å. $\frac{6}{1,000,000,000}$ in.	2 million ν	Radius of electron 1/50,000 that of atom.
	γ-rays	2½	0.06 Å. $\frac{0.24}{1,000,000,000}$ in.	50 million ν	A million cubed = number of seconds in 1,000,000 × 31,700 years.
	Gap	4	0.01 Å	300 million ν	0.01 Å. : 1 cm. = 4 M.M. : circumf. earth.
	Cosmic rays	1	0.00067 Å	4,500 million ν	
Diameter electron 0.00004 Å	Shortest known rays		0.0004 Å	7,500 million ν	0.0004 Å. : 1 cm. = 0.16 M.M. : circumf. earth.

associate with the passage of an electric current produced, but the resistance of the body to the passage of the current is manifest by rise of temperature in the tissues. Relatively large amounts of current may thus be used. The radiotherapist should take an interest in diathermy from the standpoint of inducing resistance to cancer. Murphy has shown[2] that dry heat applied to the mouse results in a marked and durable stimulation of the lymphoid elements, followed by a high degree of immunity to certain transplantable cancers. This immunity far exceeds the similar immunity produced by prophylactic use of the X-rays.

It is needless here to stress the fundamental biological importance of the electro-magnetic waves of the infra-red, visible light and ultra-violet regions of the spectrum. Especial attention has in recent years been given to the biological action of ultra-violet light. Of the studies devoted to this subject, none surpasses in interest those of Steenbock and his co-workers. These investigators have shown, among other things, that if food is exposed to ultra-violet light and then fed to growing rats, their growth is favorably affected, compared with that of rats fed with food not thus exposed. Calcium metabolism is especially affected.[3] The scientific radiotherapist is called upon to ponder over possible indirect, as contrasted with direct, effects of radiant energy, including that of X-rays and radium.

The rays of the sun which reach the earth appear, in the main, to affect those characteristics of matter which are concerned in chemical combination and in heat-production. The rays of the X-ray and gamma-ray region of the electro-magnetic spectrum appear, in the main, to affect the inner constitution of the atoms. From the biological aspect the most fundamental points thus far brought out are, first, that to those rays the most susceptible part of the cell is the nucleus, which governs morphogenic and thus indirectly all vital activities, and second, that the therapeutic value of the rays depends quite as much or more upon stimulation of defense reactions as upon a hypersensitivity of pathological tissues. That the nucleus is the part of the cell most affected is proved by the fact that if a spermatozoon is exposed to the rays and then fertilizes an egg, the effects on the development of the egg are essentially similar to those shown when the egg is given a similar exposure and then fertilized by an unexposed spermatozoon. (Bardeen, 1907; Hertwig, 1911.) The great importance in therapy of defense reactions produced by the irritation of radiation has been shown by a large number of investigators. Murphy has taken the lead in showing the importance of the lymphocytes in these defense reactions.[4] Since defense reactions play so important a part in this field, it is obvious that defense reactions aroused by the X-rays and radium should be compared with other methods of arousing such reactions, including rays of other portions of the spectrum of electro-magnetic waves. The scientific radiologist can no longer be content with playing a few notes in high treble with one finger.

CHARLES RUSSELL BARDEEN, M.D.

[2] Jour. Exper. Med., 1919, XXIX, 25.
[3] Jour. Am. Med. Assn., 1925, LXXXIV, 1093.

TO DALLAS *VIA* CHICAGO AND ST. LOUIS

If those who would like to travel together from Chicago to Dallas, *via* St. Louis, to the American Medical Association meeting in April, will write me immediately, I will try to arrange for through Pullman cars.

The Section on Radiology meetings will be held during the mornings of April 21, 22 and 23, and those who do not care to attend the earlier sessions can leave Chicago Monday night, April 19, at 11:30 o'clock, and arrive at Dallas Wednesday, April 21, at 7:00 A.M.

Those desiring to attend the American Radium Society meeting (April 19 and 20) may leave Chicago Saturday night, April

[4] Jour. Exper. Med., 1915 and subsequently.

Banquet scene, annual meeting of the Society, at Cleveland.

Leave Chicago (Michigan Ave. and 12th St.)	11:30 P.M.
Leave Chicago (53rd Street)	11:42 P.M.
Leave Chicago (63rd Street)	11:46 P.M.
Leave Springfield	5:25 A.M.
Arrive St. Louis	7:23 A.M.
Leave St. Louis (Mo. Pacific)	9:05 A.M.
Leave Bismarck	11:44 A.M.
Leave Poplar Bluff	2:15 P.M.
Leave Newport, Ark.	4:57 P.M.
Leave Little Rock	7:40 P.M.
Leave Texarkana	12:25 A.M.
Arrive Dallas	7:00 A.M.

17, at 11:30 o'clock, reaching Dallas Monday morning at 7:00 A.M.

Those desiring to join the party at Springfield, St. Louis or any other point en route may do so.

The Illinois Central and Missouri Pacific R. R. systems have been selected as the Official Routes by the Chicago Medical Society and as these are as good as (or better than) the other routes, we have selected the same.

The schedule leaving Chicago will be as at the top of this page.

Those desiring to travel *via* this route should buy their tickets *via* Illinois Central (Chicago to St. Louis) and Missouri Pacific (St. Louis to Dallas), and be sure to SECURE CONVENTION CERTIFICATE. The usual one and one-half fare for the round trip on the certificate plan is in effect.

Write the undersigned immediately, stating when you want to reach Dallas and—exactly—whether you want upper or lower berth, section or drawing room. It is possible that we may have two parties (one leaving Chicago the night of the seventeenth and arriving in Dallas on the nineteenth, and the other leaving Chicago the night of the nineteenth and arriving in Dallas the morning of the twenty-first). We can all return together, if desired.

WRITE ME AT ONCE. DO IT NOW!

I. S. TROSTLER, M.D.,
812 Marshall Field Annex,
Chicago.

STANDARDIZATION OF HOSPITALS

THE AMERICAN COLLEGE OF RADIOLOGY

When Dr. Pfahler was President of the American College of Radiology, he appointed a committee to confer with a committee from the College of Surgeons in regard to the standardization of X-ray equipment and hospital requirements for radiologists. The members of this committee are Dr. Case, Dr. Pancoast, and Dr. Hickey, with Dr. Case as its Chairman.

At a meeting of the College of Radiology in May, 1925, at Atlantic City, Dr. Case gave a verbal report from his committee, but submitted no final report in writing. The College expects that report at its meeting in Dallas. When this report is approved by our College and forwarded to the committee of the College of Surgeons, we believe that the standardization of the radiological department in the various hospitals of the country will soon be effected upon a sound and satisfactory basis by the College of Surgeons.

PACIFIC COAST X-RAY SOCIETY

The Pacific Coast X-ray Society will hold its annual meeting in Victoria, B. C., during the week of June 21-25, in conjunction with the Canadian Medical Association and the Canadian Radiological Society.

If any of the Eastern men are planning a vacation trip to the Coast, it is suggested that they include this meeting in their itinerary. The Pacific Coast X-ray Society would appreciate hearing from men con-

templating the trip who would be willing to present papers.

Any who are interested, please write to the Secretary, Dr. H. B. Thompson, 118 Cobb Bldg., Seattle, Wash.

INTERNATIONAL ASSOCIATION OF UNIVERSITY LECTURERS OF RADIOLOGY

Your collaboration is cordially invited to the furtherance of the proposed Association, whose objects are as follows:

1. The obligatory instruction of medical students in radiology in all teaching centers.
2. The formation of a curriculum for students of radiology and medical students.
3. Discussion as to the best methods of teaching and demonstrating difficult sections of radiology.
4. The compilation of textbooks for students of radiology.
5. The design and construction of models for instructional purposes.
6. Exchange of duplicates of instructional models.
7. Exchange of the scientific contributions by members and by their students.
8. Occasional congresses for the exchange of views and discussion.
9. Reform of the elementary teaching of biology and physics.
10. The introduction of a comprehensive and uniform radiologic nomenclature.

We are of the opinion that the universal spirit of confraternity, prompting the Association, will be productive of good, even where opposition is met. Until the Association possesses its own medium, its contributions will appear in existing medical journals, these contributions and correspondence to be published in English, French, and German.

Any appointed teacher of radiology is eligible for membership. The Association will receive as Associate or Honorary Members such persons as are accredited lecturers or writers on the science of radiology, although they may not be university lecturers. Recent graduates may become contributing members.

In the name of the Committee, you are invited to join the Association.

G. Holzknecht, M.D.,
R. Kienbock, M.D.,
E. Weber, M.D.,
Executive Committee.

Dozent Haudek, M.D.,
Vienne, VIII, Langegasse 63,
Secretary.

FORM

1. *Full name and address:*
2. *At what time did you finish your university studies?*
3. *Qualifications* (Professor, Clinical Professor, Associate Professor, Instructor, Associate, Assistant Professor, Assistant, etc.):
4. *In what center are you lecturing and when did you obtain your qualifications or are you lecturing without them?*
5. *What is your average number of students?*
6. *Do you specialize in any one branch; if so, what subject?*
7. *What are your contributions and where published?* (Copies will be gladly received.)
8. *Is there a growing demand for radiologic lectures in your sphere?*
9. *Are you in favor of the fusing of the physico-technologic education and medico-radiologic education of students into one branch?*
10. *Can you inform us of the names and addresses of lecturers known to you?*

The undersigned is in sympathy with the aims of the Association and wishes to become a member.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

Bronchial examination. — While studying the radium treatment of esophageal carcinoma the authors encountered a case in which, after preliminary local anesthetization of the pharynx and larynx, the patient swallowed a suspension of barium, and it was found that the liquid had entered the trachea and larynx instead of the esophagus. The entire bronchial tree became visible, but the fluid was coughed up immediately by the patient and no complication followed. Local anesthesia had abolished the laryngeal reflex, producing a transient paralysis of the laryngeal muscles. In other cases similar results were obtained owing to an ulcerating esophageal carcinoma perforating the trachea, but the filling of the bronchi was never followed by aspiration pneumonia or any other untoward result. The authors, therefore, recommend the following method of filling the bronchial ramifications with a barium suspension or lipiodol solutions. After thorough disinfection of the teeth and mouth a swab of cotton-wool, saturated in a 10 to 15 per cent cocaine solution, is applied to the pharyngeal wall and glottis by long curved forceps. When anesthesia is complete the patient is placed behind the fluorescent screen and slowly swallows the lipiodol or other solution. In most cases the fluid passes directly into the trachea and thence into the bronchial tree, and when in sufficiently small quantities can be seen entering the bronchioles. By adjusting the position of the patient the flow can be guided to any part of the lungs desired.

The authors add that when the fluid is introduced cautiously it seldom causes irritation and coughing during the examination, though shortly afterwards the greater portion is coughed up; a little fluid may remain in the alveoli, but will be finally absorbed.

The authors claim that this method is widely applicable, is not followed by any serious ill results, and that by watching the filling of the bronchi the flow of liquid can be directed and stopped as required.

The Deglutition Method in Bronchial Skiagraphy. K. Nather and M. Sgalitzer. Zentralbl. f. Chir., July 11, 1925, p. 1534. (Reprinted by permission from Brit. Med. Jour., Oct. 24, 1925, p. 60 of Epitome of Current Medical Literature.)

Micro-radio-activity in animal organs.— The author demonstrated the presence of micro-radio-activity in animal organs by a biological method. He found the element potassium to be the carrier of radio-activity. The isolated heart of a frog proved the object best suited for the

experiment. The lack of potassium caused the beating heart to stop, but the function could be restored by adding potassium to the Ringer solution. It is possible to replace potassium by other radio-active elements, for instance, uranium or thorium. Very interesting is the fact that the application of beta radiation or the adding of 4.10^{-9} grams of radium bromide per liter of Ringer solution will have the same effect, even if the heart has stopped beating for half an hour. The author concludes that the micro-radio-activity under normal conditions is on the borderline of physical measureableness and that the active amount in the functioning organism is infinitely small.

E. A. POHLE, M.D.

The Micro-radio-activity of Animal Organs and its Physiological Importance. H. Zwaardemaker. Strahlentherapie, 1925, XX, 215.

Plasma changes after X-ray therapy.—The blood of two groups of patients, one treated with a medium dose of roentgen rays for a benign pelvic condition, the other exposed to a full dose for a malignant pelvic growth, was studied as to changes of the suspension stability, surface tension, and viscosity. The author found that there was no uniform result as far as the sedimentation velocity of the red blood corpuscles is concerned; the same holds true for surface tension, while the viscosity showed mostly a slight increase. The destruction of albumin and the presence of its débris in the blood may be the cause of the observed changes.

E. A. POHLE, M.D.

Plasma Changes after X-ray Deep Therapy. R. Cordua. Strahlentherapie, 1925, XX, 322.

Treatment for deafness.—The writer discusses the various attempts to cure deafness by means of X-rays. Many writers have tried short exposures at short, often daily, intervals, and have given several of such courses. The results have not been very satisfactory and have demanded a considerable amount of attendance on the part of the patient. The writer of this paper, in conjunction with Benini, a radiologic colleague, has devised a technic which, he finds, is much less inconvenient and gives better results. He uses a current of 2 ma., a spark gap of 22 cm., with an aluminium filter of 3 mm. and a diaphragm of 6 cm. His first exposure is of ten minutes or less, according to the tolerance of the individual. He gives second, third, and fourth exposures at intervals of five or six days, increasing the dose to fifteen minutes. Usually this course results in considerable improvement, but if there is none the treatment is not continued. If a moderate amount of improvement accrues, another two doses are given, and after a month's rest the series can be repeated. Fifteen patients with catarrhal otitis were so treated; five had a history of only six months, but all were markedly improved as regards tinnitus and acuity of hearing. Two patients with dry catarrh with internal ear affection were treated and one showed improvement as far as tinnitus and vertigo were concerned, but with no gain in hearing. The other case was not traced. In two cases of resolved suppurative otitis no benefit followed. Of five cases of oto-sclerosis two were definitely improved as regards tinnitus but not as regards hearing. One patient was a married woman who was treated through pregnancy and parturition without any increase of deafness. One case of auditory nerve deafness treated was not improved. The author concludes that catarrhal otitis and some cases of oto-sclerosis can be greatly benefited, but that nerve deafness and the results of suppuration do not respond to treatment.

X-ray Treatment of Catarrhal Otitis Media. C. Grande. Arch. Ital. di Otol., Rinol. e Laringol., April, 1925, p. 197. (Reprinted by permission from the Brit. Med. Jour., Aug. 22, 1925, p. 25 of Epitome of Current Medical Literature.)

Roentgen- and organotherapy of thyroid.—In this first paper Borak discusses the disturbance of inner secretion of the thyroid. He points out that organo- and roentgen therapy have entirely different mechanisms; the organotherapy is a compensation therapy of a hypofunction, while the X-ray therapy, as well as surgery, is a reduction therapy of a hyperfunction. He believes that the roentgen-ray effect is due to a direct influence upon physical-chemical processes in the protoplasm of the gland cells. An injury of the nuclei by the summation of the X-ray dose manifests itself in the reducing of the size of the thyroid. A series of small doses is advocated, to avoid the overflooding of the system with thyroid secretion caused by one large dose. The thymus seems to play a certain rôle in cases of Basedow's disease; it is advisable to treat this gland also. The relation of the ovary to this problem will be discussed in a second paper.

E. A. POHLE, M.D.

The Roentgen- and Organotherapy in Inner Secretory Diseases. Part I.—The Thyroid. J. Borak. Strahlentherapie, 1925, XX, 232.

Technic for uterine therapy.—This report is based on the treatment by mild applications of roentgen ray to 60 cases of benign disorders of the uterus, with hemorrhage as the presenting symptom. Four anterior areas, each 2 inches square, were treated for four minutes, at 10-inch

distance, with 3 mm. of aluminum, and 8-inch spark gap at the first treatment. If needed, a second application was given to the back, with the same factors, in three weeks, using five areas, three vertical and two lateral, in the form of a cross. A third application, if needed, was given in six weeks or two months, using lateral areas if any skin effect was present on the abdomen.

Of the 60 patients, 40 had metritis, 17 fibroid tumors, and 3 general conditions characterized by uterine hemorrhage. Ages ranged from 30 to 60. Hemorrhage was completely controlled in 50, menstruation continued but excessive hemorrhage was stopped in 6, and other measures were required in 4.

Emphasis is placed on the mild dosage, the high percentage of good results, and the superiority of this method to radium. In 7 patients bleeding stopped after one treatment, in 25 after two, in 12 after three, and in 8 after four. Pain, backache, etc., were often relieved.

CHARLES D. ENFIELD, M.D.

The reviewer is inclined to wonder in what manner the author has been in the habit of applying radium that his results have not been as good as these, since in his experience most of these cases would have been controlled by a single dose of radium, properly administered.

Control of Uterine Hemorrhage by the Roentgen Ray. William S. Newcomet. Jour. Am. Med. Assn., Nov. 7, 1925, p. 1459.

Ultra-violet energy.—The writer, as the result of his experience and a study of the literature, has come to the conclusion that in ultra-violet energy intelligently used, the physician has under his control a force which is (1) a direct germicide, (2) an indirect germicide, (3) a counter-irritant, (4) a means of producing increased resistance to infection, (5) an analgesic, (6) a means to depress metabolism, (7) a means to stimulate metabolism, (8) a means to stimulate the sympathetic nervous system, (9) a means to regulate mineral metabolism, (10) a means to balance endocrine secretions, (11) a means to overcome disturbances caused by vitamin deficiencies.

Indications for the Use of Ultra-violet Energy. L. C. Donnelly. Brit. Jour. Radiol., May, 1925, p. 183. (Reprinted by permission from Brit. Med. Jour., Aug. 22, 1925, p. 25 of Epitome of Current Medical Literature.)

Pituitary lesions.—The surgery of the pituitary body, as practised to-day, has limitations, proportionate in large measure to the duration of the lesion. When surgery is recognized as an essential factor in the treatment of the pituitary lesion in the early stage, before optic atrophy is advanced and before the terminal stages of functional disorder are reached, there will be a decided improvement in the operative results and a lower mortality. The surgeon has been handicapped because he has been confronted so often with terminal effects.

W. W. WASSON, M.D.

Pituitary Disorder: A Digest of One Hundred Cases, with Remarks on the Surgical Treatment. Charles H. Frazier and Francis C. Grant. Jour. Am. Med. Assn., Oct. 10, 1925, p. 1103.

Roentgen-ray effect on food.—The authors discuss the direct and indirect effect of X-rays on organs and organisms as a whole, and come to the question, "Is it possible to cause the same effect by not exposing the organism directly to radiation?" They decided to irradiate the food (bread and vegetables) of white mice and rats; in twelve weeks all fifty animals living on the irradiated nutrition died, while forty-seven of the controls were alive. Autopsies of the fifty animals showed changes in almost all inner organs; there was also marked pathology in the bones, similar to rickets. The destructive effect is proportional to the X-ray energy absorbed by the food.

E. A. POHLE, M.D.

Studies of the Effect of X-rays upon Food. F. Ludwig and H. Hopf. Strahlentherapie, 1925, XX, 342.

Action of radium on viruses.—The authors exposed a suspension of *Leishmania tropica* to the action of 4 mg. of radium enclosed in a platinum cell 1/5 mm. in thickness for twenty-four hours, and then inoculated it along with an unexposed control onto a culture medium. Similar growths were obtained in each case. The action of 10 mg. of radium for sixty hours caused a delay of one week in the growth of the organism. For complete sterilization an exposure of 4 mg. for seventy-two hours was required. A similar sterilizing effect was produced by radium emanation acting in a dose of 5 millicuries for sixty-two hours in a closed space. The strange observation was made that though both the radium and the radon rendered the organism incapable of multiplying on a nutrient medium, they failed to destroy its motility.

With *Trypansoma inopinatum*, a frog parasite, the same results were obtained. The ability to grow on an artificial medium and the ability to infect frogs were both destroyed, but the motility remained intact.

Again, with *Spirochæta icterohæmorrhagiæ* the results were similar: 8 mg. acting for twenty-six hours rendered the spirochete incapable either of growing *in vitro* or of giving rise to

disease in the guinea pig, but did not interfere with its motility.

The authors conclude that the action of radium on protozoa and spirochetes consists essentially in interference with their power of division.

In another paper in the same issue (p. 852), R. Bruynoghe and Le Fèvre de Arric report their experiments on the action of radium on the filterable viruses. The suspension to be tested, either of the rabic, the encephalitic, or the herpetic virus, was diluted 1 in 100 or 1 in 1,000 times, and divided into two portions, of which one was exposed to radium emanation in a dose of 5 millicuries for about forty-eight hours. Both portions were then injected intracerebrally into rabbits. It was found that the irradiated suspensions were in each case unable to give rise to disease, whereas the control suspensions uniformly killed the animals in from three to seven days. It would appear, then, that the filterable viruses are characterized by a similar susceptibility to the action of radium emanation.

The Action of Radium on Protozoa and Filterable Viruses. R. Bruynoghe and A. Dubois. C. R. Soc. de Biologie, Sept. 30, 1925, p. 849. (Reprinted by permission from Brit. Med. Jour., Nov. 7, 1925, p. 70 of Epitome of Current Medical Literature.)

Treatment of leukoplakia.—This is a study based on 40 cases observed by the author, who concludes that there is a frequent, though by no means invariable, connection between this disease and syphilis. The same statement might apply to the use of tobacco. If untreated, leukoplakia frequently, but by no means invariably, goes on to malignancy. In the matter of treatment, the author inclines to prefer the actual cautery or radium. He concludes that prophylaxis is most important, and that any form of treatment is apt to prove unsatisfactory.

CHARLES D. ENFIELD, M.D.

Leukoplakia Buccalis. Howard Fox. Jour. Am. Med. Assn., Nov. 14, 1925, p. 1523.

Light treatments.—Dr. Levick believes that the results from artificial light treatment in no way fall short of those which result from exposure to sunlight alone. The apparatus used at Chailey combines the mercury vapor lamp and long rays from a lamp of original designing. The author believes this a superior combination.

Wounds are often treated in open air, by being kept warm in cold weather by heat rays from the lamp. The wound is not dressed at any time, as the air seems to have a desirable effect. Tuberculous ulcers and sinuses seem to respond particularly well to light treatment.

B. C. CUSHWAY, M.D.

It seems to the abstractor that from the enormous amount of data that are pointing to excellent results from the various forms of light, the medical profession is only marking time while delaying to make use of them. One need only see the flock of patients in the office of any one doing this work to realize that the people as a whole are satisfied. It would seem that that indicates satisfactory results.

Heliotherapy and Actinotherapy at the Heritage Craft Schools, Chailey. George Murray Levick. Brit. Jour. Tuberc., July, 1925, XIX, 144.

Thymus in infants.—The authors report the treatment of 125 infants on whom a combined roentgen-clinical diagnosis of thymus disease had been made, with roentgen rays or radium. In X-ray treatment, the factors were 5 ma., 10 in. distance, 1 mm. of Al., 1 minute exposure. In radium treatment, 100 mg., 3 mm. of brass, 5 cm. distance, time not stated. The results appeared to be uniformly good.

CHARLES D. ENFIELD, M.D.

Thymus and the Treatment of its Hyperfunction. Lawrence R. De Buys, Ernest C. Samuel, and Eleazar R. Bowie. Jour. Am. Med. Assn., Nov. 14, 1925, p. 1551.

Effect of roentgen rays on bacteria.—After discussing, in detail, the literature on the influence of X-rays on bacteria, the author presents the results of his investigations dealing with the exposure of cultures of *bac. staphyl.* and *bac. coli* to unfiltered X-ray doses from 600 to 7,200 Roentgen. He finds that even the highest dose does not sterilize fresh cultures. Very slight biological changes were noticed at the edge of colonies growing on agar plates after the administration of 42,000 Roentgen. The growth was also inhibited when using the India ink culture method. It could be demonstrated that small exposures, as low as 1,200 Roentgen, showed that inhibitive effect on the growth. It also was proportional to the dose. The sterilization took place only in cultures of 28 to 30 days, using the dose of 66,000 to 72,000 Roentgen.

E. A. POHLE, M.D.

Effect of Roentgen Rays on Bacteria. H. Klovekorn. Strahlentherapie, 1925, XX, 354.

Pituitary neoplasms. — Hypophysial enlargements may be considered from two points of view, (1) a destructive, rapidly growing neoplasm, and (2) benign adenomas, strumas or a hyperplastic state. Without question, the former type eventually needs operation; most of the latter are amenable to medical treatment,

including glandular radiotherapy, in the same manner that the thyroid is subject to similar medical therapy, surgical treatment being used when necessary. The glandular therapy recommended is desiccated pituitary body by mouth and pituitary extract hypodermically. Combined with this, any necessary supportive or substitutive therapy should be given to other endocrine organs. Many patients recovered under the foregoing treatment.

W. W. WASSON, M.D.

Medical Treatment of Pituitary Neoplasm. Irving H. Pardee. Jour. Am. Med. Assn., Aug. 15, 1925, p. 513.

Esophagus destroyed by nitric acid.—A girl 20 years old attempted suicide by ingesting nitric acid. Was attended for sixteen days by local physician before being referred to the author. Examination revealed that hypopharynx, palatoglossal pillars, and tonsils had been corroded and were granulating. The epiglottis was ragged and granulating; vocal cords reddened, but not corroded; voice a whisper.

Admitted to the Good Samaritan Hospital, Los Angeles, Oct. 14, 1912. Delay in passing the esophagoscope was decided upon. October 16, the glottis was cocainized and the patient encouraged to swallow milk. She failed. Attempt was made to pass the esophagoscope. Failure resulted. Gastrostomy was performed. Patient so fed while in hospital. Several months later girl developed lobar pneumonia and died. Autopsy revealed esophagus to be completely destroyed; trachea rested against the vertebral column.

This case is in the nature of a retrospect. With the present development of endoscopy and X-ray it is possible that a case of this kind would be handled differently. The absence of the esophagus would have been noted immediately and the gastrostomy done sooner.

B. C. CUSHWAY, M.D.

Total Destruction of Esophagus by Nitric Acid. Clarence Ide. Laryngoscope, Nov., 1925, p. 869.

Infection from dental abscesses.—The author describes a case of acute dacryadenitis, a somewhat rare condition, the etiology of which is usually not very clear. In the present case, however, it would appear that the teeth were quite definitely to blame. A man, aged 27, woke up one morning with intense pain in the left eye. On the bulbar conjunctiva two red vascular bands were found, which extended upwards and outwards to the fornix. On everting the lid a red tender mass presented in the region of the accessory lacrymal gland. Hot fomentations were applied, and during the next few days the pain and swelling subsided. On the sixth day, however, a relapse occurred. X-ray films of the teeth revealed abscesses at the roots of the two left upper incisors. These teeth were extracted and a remarkably rapid improvement in the condition of the eye followed. There was no recurrence.

Acute Dacryadenitis Caused by Focal Infection. M. L. Foster. Arch. Ophthalmol., Sept., 1925, p. 430. (Reprinted by permission from Brit. Med. Jour., Oct. 24, 1925, p. 60 of Epitome of Current Medical Literature.)

Thyroid.—Adenomatosis is a definite pathologic entity differing from adenoma in that the process is diffuse and does not have a true capsule. It produces a hyperthyroidism of the cardiovascular type.

The writer states that it is important to differentiate between adenoma and adenomatosis because the former requires simple enucleation of the tumor growth, while the latter requires subtotal double lobectomy.

W. W. WASSON, M.D.

Adenomatosis, or the Diffuse Adenomatous Goiter. J. Earl Else. Jour. Am. Med. Assn., Dec. 12, 1925, p. 1878.

Sign in gastro-intestinal perforation.—Free air in the peritoneal cavity is pathognomonic of gastro-intestinal perforation and was found on fluoroscopic examination in 86.2 per cent of a series of twenty-nine proved cases of acute perforation of gastric or duodenal ulcer. This free air is easily seen on fluoroscopic examination without previous preparation or use of a contrast meal. The sign appeared in the earlier stages of perforation and was present two hours after the onset of the trouble in one of the cases. The free air is recognized by observing a narrow, sickle-shaped zone of freely shifting air between the viscera and the abdominal wall or between the diaphragm and the upper surface of the liver. The air changes location with change of posture of the patient. The procedure is apparently without harm and does not produce discomfort to the patient. The information gained is easily worth the few minutes that it takes to examine the patient in the manner described.

The sign is not offered as a substitute for the diagnostic procedures usually done in these cases, as a diagnosis can be made in most in-

stances on the history and physical examination. The sign is offered as a valuable addition to our diagnostic armamentarium in the recognition of acutely perforated gastric and duodenal ulcer, because it is practically pathognomonic.

W. W. WASSON, M.D.

Roentgen Ray in the Diagnosis of Perforated Peptic Ulcer. R. T. Vaughan and William A. Brams. Jour. Am. Med. Assn., Dec. 12, 1925, p. 1876.

Roentgen therapy for the tuberculous.— In general, tuberculous patients show a hypersensibility to the roentgen ray and this must be borne in mind in considering any treatment. The skin, in particular, is hypersensitive, and, because of this, care must be taken that no irritants, especially iodine, have been or are being applied during the X-ray treatments.

Three hundred fifty-one cases of tuberculous lymphoma were treated, with two hundred thirty-four after-controlled beyond a year. Relapses, or new glands in 4 per cent, non-dangerous skin changes in 12 per cent, atrophy and telangiectasis in 3 per cent, no necrosis, no permanent alteration of function of the salivary glands.

A voltage giving an equivalent spark gap of twenty-five to thirty centimeters, according to the depth of the process, was used. The usual filter was three millimeters aluminum, though occasionally 0.25 mm. Cu. and 0.5 mm. Al. were used. Careful individualizing of the dose is necessary, but an average of one-third H.E.D. through each field of entry was used—never increased beyond 50 per cent. A series was not repeated under four weeks and the interval increased if more than three series were needed.

The conclusions reached are: (1) The roentgen therapy is comfortable for the patient, can be administered polyclinically, and gives results which at least are not surpassed by other competing methods. (2) The condition of the diseased gland has in some degree an influence on the duration of the treatment but not on the final result. (3) A careful and individualized technic gives good cosmetic results and reduces local secondary alterations to a minimum.

Tuberculous peritonitis should be treated unless there is a progressive lung lesion, ulcerative colitis or signs of intestinal obstruction, and whether a laparotomy has been performed or not. Not more than one-third H.E.D. per field of entry was given to the abdomen and the back, using for children 0.25 Cu. and 0.5 Al. and for the adults 0.5 Cu. or Zn. and 1 Al. Each series was spread over several days and not repeated in less than four weeks. Of 24 cases examined afterwards, 15, or 60 per cent, were cured, transient improvement was seen in 6, and no effective change in 4.

In tuberculosis of the female genital organs roentgen irradiation offers the best hope of cure. Out of 10 treated, 7 were cured, 2 are still under treatment, and 1 has disappeared. Eight cases of tubercular epididymitis and one of deferens relapse were treated and all restored to health. Good results were obtained in the treatment of fistulæ and nests of disease in soft tissue. In tuberculosis of bones and joints roentgen treatment is gaining a good position, but especially so in regard to the small bones and joints.

ROBERT S. STONE, M.D.

Roentgen Therapy in Surgical Tuberculosis. G. A. Watterstrand. Acta Radiologica, Dec., 1925, Vol. 4, Fasc. 6, p. 528.

Pneumo-mastoid. — Recurrences of inflammatory process in the mastoid after operation are not uncommon. Because of the previous exenteration and wide open antrum the extension of infection from the epipharnyx to the tympanum and mastoid is easily understandable. Even in the case of marked swelling and fluctuation in such a patient, the presence of something other than an inflammatory process must be kept in mind, as the following case demonstrates.

E. W., age 16, white, male, appeared for examination June 27, 1924, because of pain in the right ear. On June 23, 1924, the patient had contracted a cold, which was followed next day by pain in the ear. The day prior to the examination the drum membrane had ruptured spontaneously.

Family history: Mother and two sisters died of pulmonary tuberculosis.

Examination revealed the following: Right ear drum membrane bulging, in spite of the purulent discharge from spontaneous rupture. Left membrane retracted. Hearing: right, W. V. 12 feet; left 35 feet.

June 27, 1924, myringotomy, right. July 3, 1924, myringotomy repeated. July 8, 1924, acute mastoid exenteration. Operation revealed a rather extensive necrosis of bone, and much pus. Patient made uneventful recovery. August 18, 1924, tonsillectomy and adenoidectomy.

November 25, 1924, patient returned, complaining of pain in right ear. Examination revealed swelling over the mastoid area, normal temperature, normal white blood count, tenderness over right mastoid area.

Under anesthesia, incision was made over area of swelling. A "pop" of escaping air was noted. No pus, no evidence of inflammatory change.

Air began to bubble in and out of the mastoid cavity.

Conclusions: In this case, considering the normal temperature and normal white blood count, negative ear drum, etc., pneumo-mastoid should have been kept in mind. Had the case not been subjected to surgical intervention the trapped air would doubtless have been absorbed, and most probably there would not have been a recurrence.

B. C. CUSHWAY, M.D.

Report of a Case of Pneumo-mastoid. Louis K. Guggenheim. Laryngoscope, Nov., 1925, p. 868.

Deep therapy. — The author upholds the value of moderately deep radiotherapy in those conditions where it is indicated, against the universal use of "deep therapy." For its successful use a more precise technic is required because of the more manifest direct results and, therefore, it is neglected. The amount of radiation absorbed by the various layers of tissue is the important factor. Consequently, to treat a specific lesion, the particular type of ray that is most absorbed by that lesion, with the least effect on deeper and surrounding tissues, should be chosen. A varying spark gap from fifteen to twenty-five centimeters and a varying filtration from nothing to one centimeter of aluminum, is the range considered as moderately deep. In all skin conditions and some adenopathies this technic is far superior to deep therapy. In other conditions such as neuritis, myeloid leukemia and Graves' disease it gives as good results as the other. In the absence of the malignancy factor, the topographical situation, the volume and extent of the lesions are the factors governing the choice between the two. Thus radiotherapy comprises a whole series of methods for which the indications are different.

ROBERT S. STONE, M.D.

Moderately Deep Radiotherapy. J. Belot. Acta Radiologica, Dec., 1925, Vol. 4, Fasc. 6, p. 513.
